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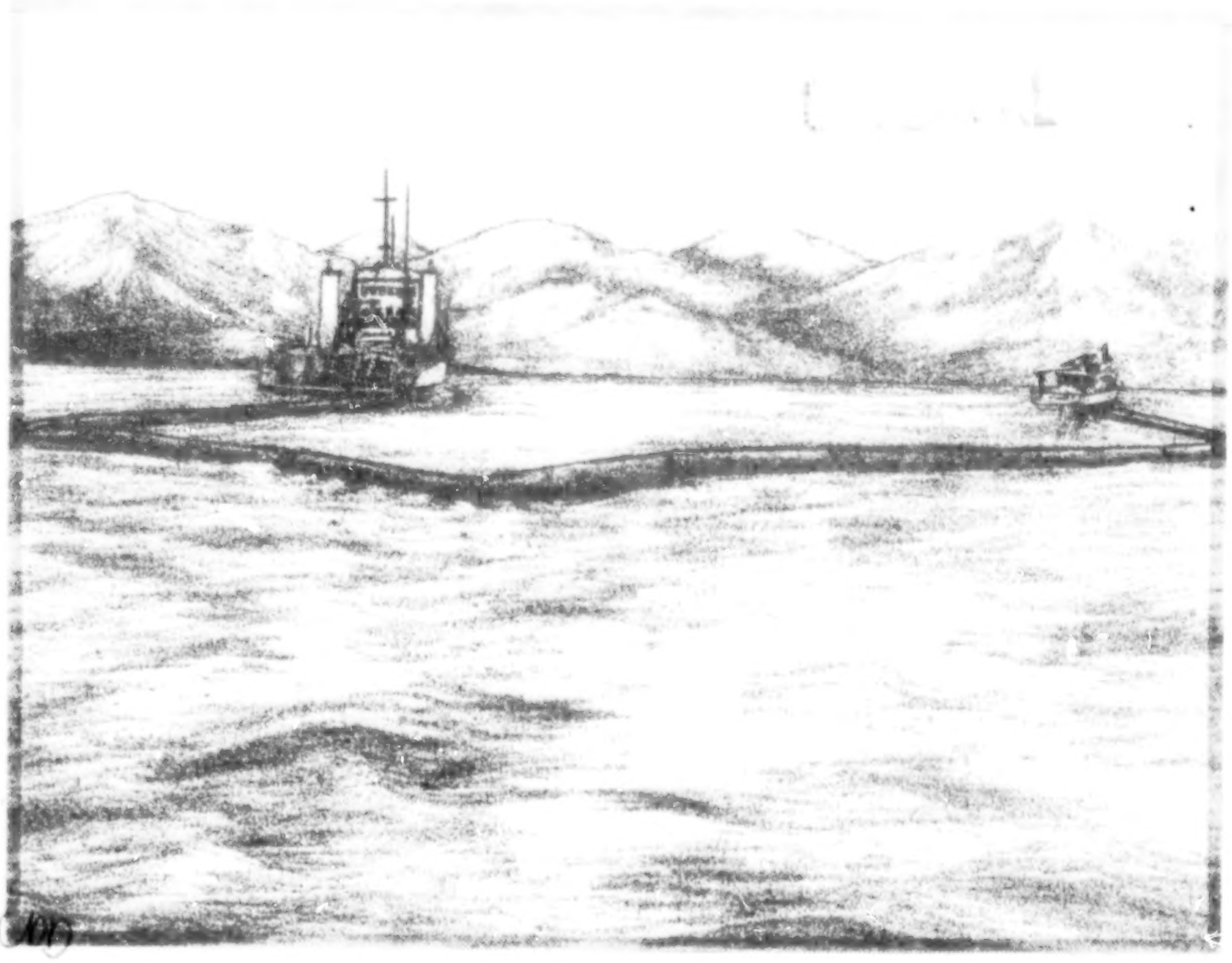
Alaskan Outer Continental Shelf

OCS Report
MMS 87-0062

Oil-Spill-Response Measures for Offshore Oil and Gas Operations



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Alaskan Outer Continental Shelf

OCS Report
MMS 87-0062

Oil-Spill-Response Measures for Offshore Oil and Gas Operations

by

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INTRODUCTION

The purpose of this paper is to examine spill-response capabilities for arctic and subarctic Outer Continental Shelf (OCS) areas. The effectiveness of oil-spill-response efforts for arctic and remote frontier areas on the Alaskan OCS is a controversial subject. Because most of the oil spilled offshore Alaska has been related to marine commerce and little has been recovered, it is often concluded that the oil industry cannot effectively clean up oil spilled offshore Alaska. However, there has not been a major drilling- or production-related oil spill on the Alaskan OCS that can be used to evaluate industry's response capabilities.

The Alaska OCS Region of the Minerals Management Service (MMS) must evaluate spill-response capabilities as part of the decision-making process for leasing offshore tracts and for permitting of offshore oil and gas operations. This paper will assist in this process by examining spill-response capabilities for arctic and subarctic OCS areas. The paper begins with a discussion of the regulatory requirements for pollution prevention and oil-spill-response planning, then describes the spill-response organization that industry has established to meet these requirements. Finally, the paper examines the spill-response measures that have been proposed for the Alaska OCS Region and the research and development efforts to improve spill-response capabilities.

Both industry and Government have made a considerable effort to assess spill-response technology in arctic and subarctic regions. Recent work includes: A Field Guide for Arctic Oil Spill Behavior, prepared for the U.S. Coast Guard (USCG) by ARCTEC Incorporated, Oil-Spill Response in the Arctic, Part 3, prepared by Spiltec for an oil industry task group, and the Office of Technology Assessment report entitled Oil and Gas Technologies for the Arctic and Deep Water. These documents, which build on the extensive amount of available information and the continuing research being done in this area, serve as useful reference material.

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I. REGULATORY REQUIREMENTS

This chapter describes the regulatory requirements of the MMS that govern oil-spill-contingency plans (OSCP's) and pollution prevention on the Alaskan OCS.

The responsibility to protect the marine environment from oil pollution is established by the OCS Lands Act, as amended. The MMS has promulgated a series of regulations, OCS Orders, and guidelines that specify performance standards for lessees conducting oil and gas operations on the OCS.

In particular, Alaska OCS Order No. 7 and the MMS Planning Guidelines for Approval of Oil-Spill-Contingency Plans, dated July 29, 1982, prescribe measures required of each lessee for pollution prevention and control. Alaska OCS Order No. 7--which was developed to recognize unique Alaskan conditions, including drilling from artificial gravel islands--includes requirements for inspections and reports, pollution-prevention and -control equipment and materials, OSCP's, annual pollution-response drills, communications, dispersant use, and training of personnel. The planning guidelines include provisions relating to risk analysis, equipment availability, response times, use of dispersants, support vessels, detection and monitoring, and disposal of oil and oily waste (included in Appendix B). These guidelines, developed in accordance with the Memorandum of Understanding (MOU) of December 18, 1980, between the Department of the Interior (DOI) and the Department of Transportation (DOT), provide criteria that is used to evaluate the adequacy of site-specific contingency plans. The MOU further identifies the responsibility of the USCG to participate in the review of contingency plans.

A. Oil-Spill-Contingency Plan: The MMS judges the adequacy of lessees' spill-response preparedness through review of their OSCP's. Each lessee is required to submit an OSCP to the Regional Supervisor, Field Operations (RSFO), MMS, for approval with--or prior to the submission of--an exploration plan (EP) or a development and production plan (DPP). The OSCP is developed for the site-specific proposal, based on the type, timing, and location of proposed operations. The OSCP must satisfy the content requirements and provisions established in Section 3.2 of Alaska OCS Order No. 7 and in the Planning Guidelines for Approval of Oil-Spill-Contingency Plans.

The OSCP's must contain an estimate of the number and size of spills that could occur as a result of the proposed activity. They also must include a trajectory analysis for oil-spill movement based on expected meteorological and oceanographic conditions for the area during the timeframe of the proposed operations.

Estimates of the number and size of spills can reflect worldwide, national, regional, or company-specific historical data. For OCS exploratory operations, MMS statistics indicate that a significant oil spill resulting from loss of well control or other catastrophic event(s) has a very low probability of occurrence. However, a spill of this magnitude is included in contingency planning. The size of a spill from a loss of well control would vary considerably, depending on the characteristics of the well, the reservoir from which the oil is flowing, and the duration of the flow.

Table 1
Spills Per Billion Barrels

	1,000 barrels or greater	100,000 barrels or greater
Platforms	1.0	0.036
Pipelines	1.6	0.065
Tankers		
At Sea	0.9	0.19
Per port call	0.2	0.042

Source: Norton Basin Sale 100 Final EIS, December 1985.

Flow rates--typically 5,000 to 10,000 barrels (800-1,600 cubic meters [m^3]) per day over a 10- to 30-day period--have been used in contingency planning for exploratory operations in the Alaska OCS Region. Such large flow rates are, however, extremely unlikely.

The most likely spill to occur is one resulting from normal operations, such as fuel transfers. Fuel-storage capacities and equipment-operating characteristics are used to estimate the potential size of operational spills from exploratory operations. For production operations, more refined estimates of spill frequency and size would be determined based on production rates, volume of storage, pipeline characteristics, and transportation modes.

The MMS uses spill-rate constants to predict the number of spills most likely to occur from production operations. These constants, which were developed by Lanfear and Amstutz, are based on historical OCS operations. They are used to predict the number of spills likely to occur per billion barrels produced or transported and are summarized in Table 1.

The trajectory analysis contained in the OSCP is used for planning purposes; it is not intended to be a conclusive assessment of spill movement. Lessees often use the lease-sale environmental impact statement (EIS) trajectory analysis when the EIS launch points are in close proximity to their proposed operations. Lessees also may also use their own model or trajectory analysis. The MMS evaluates the results of such models to ensure that they are representative of spill movement for the area of proposed operations.

The OSCP must identify potential areas that could be contacted by an oil spill from the proposed operations and identify and describe strategies for the protection of these areas. Strategies involve identifying sensitive and vulnerable biological resources or habitats, estimating the time it would take an oil spill to contact these areas, and identifying the equipment and logistics that would be available to respond to these areas in the event of an oil spill. Strategies are usually identified through individual scenarios or through a narrative description of the decision process for implementing the contingency plan.

The OSCP also must identify biological and cultural areas that may be sensitive to oil spills; these areas usually are highlighted through the lease-sale EIS process and are identified in the Notice of Sale (NOS). In addition, the State of Alaska's Coastal Management Program (ACMP) and local district plans may identify areas of concern, and lessees are encouraged to consult with local communities to identify such areas and incorporate them in contingency planning. Communities may also identify areas of concern during the EP regulatory review process. Where it appears that the type and amount of equipment and logistics are not capable of providing an effective contingency response to protect the identified areas of concern, MMS would either disapprove the plan or require modification of the contingency plan to improve the response capabilities.

In addition, the OSCP must identify the types of cleanup equipment available to the operator; identify and include in an inventory the contingency resources within the area of operations, both committed and uncommitted to

3

the proposed operation; and discuss the process for obtaining such equipment. Response equipment must be suitable for the environmental conditions anticipated at the location and for the period of operations.

The planning guidelines state that "open-water recovery devices typically have a recovery capacity of at least 1,000 barrels of oil per day" and that "state-of-the-art equipment is capable of operating in 8- to 10-foot seas and 20 knot winds, with deployment in 5- to 6-foot seas and 20 knot winds." The planning guidelines recognize that mechanical equipment cannot be expected to operate efficiently in all environmental situations and that local environmental conditions, such as high-energy sea states with short wavelengths or severe icing, may not allow the criteria for deployment and operations to be met. If the sea states for the location of proposed operations do not approach 8 to 10 feet, contingency equipment that is appropriate for lesser conditions is considered acceptable. For example, initial exploratory drilling in Norton Sound, Sale 57, occurred during the months of June, July, and August of 1984 and July and August of 1985. During this timeframe, significant wave heights of less than 5 feet occurred on an average of 75 percent of the time. Spill-response equipment for this area was approved using criteria of less than 8- to 10-foot seas. However, additional equipment that is capable of operating in higher sea states was available through Alaska Clean Seas (ACS) and included in the contingency plan.

The target for initiating recovery operations at the spill site is 6 to 12 hours from the time of the spill. The 6- to 12-hour range for response times provides flexibility to accommodate the large variations in the distance of leased lands from onshore-support sites and the diversity of locations where operations may be conducted. Should the risk analysis indicate that an oil spill is likely to contact a shoreline, environmentally sensitive area, or potentially vulnerable resource sooner than 6 hours, response times are required to be reduced to ensure protection of these resources. In the event of a spill, cleanup equipment must be fully deployed and in operation within the specified response time, weather permitting. The location of staged equipment must satisfy response-timeframe requirements. For spills that exceed the capabilities of immediate response equipment, the operator must be capable of obtaining additional equipment within 48 hours from the time of the spill. In some remote areas, such as the Navarin Basin, the timing of spill movement and logistical support may justify a longer secondary response time, provided biologically sensitive resources or habitats would not be at risk.

Dispersants and dispersant-application systems are required to be available for use by the lessee in responding to spills, and the OSCP must contain detailed provisions for a dispersant response. The procedures for receiving approval for dispersant applications are addressed in the National Oil and Hazardous Substances Pollution Contingency Plan. The USCG and Regional Response Team are currently developing dispersant-use guidelines for Alaska. To date, guidelines have been developed for the Cook Inlet region and establish specific zones where dispersants can and cannot be used.

Lessees must designate a spill-response coordinator who is charged with the overall responsibility to direct and coordinate response operations. The OSCP also must (1) identify an operator's representative who has the authority to order ignition of an uncontrollable well that is causing a massive spill and (2) provide guidelines that would be used to make a decision to ignite the well.

In addition, the OSCP must provide for the detection of an oil spill, for monitoring its movement, and for disposing of recovered oil and oil-contaminated materials; and it must establish the framework for the logistical support necessary to transport, deploy, and operate response equipment.

B. Training and Oil-Spill-Response Exercises: Operators must provide for the training of response personnel, who must be familiar with the equipment and strategies for spill response as identified in the OSCP. The lessee is responsible for conducting a response drill to demonstrate familiarization with pollution-control equipment and operational procedures, which must be held at least once every 12 months. The MMS requires that the initial response drill be conducted prior to the commencement of operations or, for exploratory drilling, prior to drilling below the structural casing.

The MMS requires each lessee to submit a response-drill scenario. The scenario is reviewed by MMS in consultation with the USCG to ensure that it is representative of the oil-spill-response measures identified in the OSCP. The personnel identified in the plan as members of the on-site spill-response team must participate in the response drills, which also must be attended by a representative number of personnel from each shift. Equipment-deployment exercises are held in the area of operations under realistic environmental conditions. If an exercise is not conducted at the site of operations, it must be held at a location that has realistic environmental conditions--conditions that are representative of the seasonal timeframe in which the operations will occur and are suitable to demonstrate effective use of offshore spill-response equipment. Realistic environmental conditions should not be interpreted to mean average or worst-case conditions. Because it is not the purpose of an exercise to test the capability of equipment to operate in maximum sea states, exercises need not be conducted under worst-case conditions. The purpose of an exercise is to demonstrate that the equipment is available and functional and that crews are familiar with its deployment and operation.

More than one drill may be required if seasonal conditions in the area (i.e., solid ice, open water, or broken ice) require the demonstration of different equipment and techniques. Oil-spill-response demonstrations are viewed and evaluated by representatives of the MMS and the USCG, and they may be attended by representatives of the State of Alaska and local government. If problems or deficiencies are identified as a result of the oil-spill-response demonstration, corrective actions by the lessee are required. In cases where equipment does not operate properly (i.e., pumps, generators, etc.), MMS will conduct a subsequent inspection to ensure that the equipment is replaced or repaired and is operable. If personnel are unfamiliar with deployment and/or operation of equipment or if weather conditions prevent deployment of equipment, an additional drill will be required.

In addition to response-drill training, all drilling personnel must receive MMS-approved well-control training in accordance with standard MMSS-OCS-T 1, May 1982. This standard was developed to provide the criteria necessary to ensure that drilling personnel understand the mechanics of well control and can properly conduct a well-killing operation; it includes thorough training on MMS standards, drilling fluids, warning signals and causes of kicks, shut-in procedures and equipment, and procedures to regain control of the well. This well-control training reduces the chance of a blowout.

C. Other Requirements: Lease-sale stipulations included in the NOS for a given sale may include additional requirements for oil-spill-response preparedness. Such stipulations are specific to the entire sale area or a portion thereof, and the OSCP must incorporate equipment and actions that assure compliance with applicable stipulations before MMS would approve the EP. To date, these stipulations have centered on spill response during broken- or pack-ice conditions and have provided for MMS and State review of the oil-spill-response capabilities to determine if the lessee has demonstrated the theoretical and physical capability to detect, contain, clean up, and dispose of spilled oil in these conditions. The stipulations have prohibited exploratory drilling below a threshold depth during broken- or pack-ice conditions until the provisions of the stipulation have been met and, in some cases, have identified the responsibility of the State to concur on these lessee capabilities before the OSCP is approved. The MMS has approved drilling operations during the broken-ice period for several exploratory wells based on each individual lessee's demonstrated ability to respond to a spill under this condition in the lessee's area of operation.

Other lease stipulations and Information to Lessees (ITL's) included in the NOS identify seasonal drilling restrictions that prohibit exploratory drilling and other downhole activities except testing through casing during the presence of endangered whales. These stipulations and ITL's, which were developed to minimize the potential for an oil spill occurring at the same time whales would be in an area of operations, reduce the risk to endangered whales from the effects of spilled oil and provide an added level of protection to whales in addition to contingency response capabilities.

D. Regulatory Review: Upon receipt of an OSCP in conjunction with an EP or DPP, the MMS conducts an internal review and distributes copies of the plan to the State of Alaska, other Federal agencies, and other parties as identified by the State for coastal zone management (CZM) consistency review and comment. The MMS also makes copies of the OSCP available for public review and notifies interested parties of plan availability. The USCG, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Army Corps of Engineers, Environmental Protection Agency, and the National Park Service all receive copies of the OSCP and make their recommendations to the RSFO. The State of Alaska, Office of Management and Budget, coordinates the review of the OSCP for consistency with the State's CZM program, which includes input from affected local communities and State agencies. If the State finds an EP and associated OSCP inconsistent, the OSCP must be modified to make it consistent. The MMS cannot approve an Application for Permit to Drill until (1) the lessee has received coastal consistency concurrence from the State, (2) concurrence can be conclusively presumed, or (3) the Secretary of Commerce overrules the State on appeal by the lessee.

The regulatory review process provides the opportunity for review and comment on the OSCP by the public and by Federal and State agencies. Resource agencies are afforded the opportunity to review the accuracy and completeness of the sensitive biological habitats and areas identified in the plan. The USCG and the State of Alaska, Department of Environmental Conservation, evaluate the appropriateness of the equipment and technology identified in the OSCP. The review process provides the opportunity to comment on the applicability of the dispersants, disposal methods, equipment, strategies, and response techniques identified in the OSCP. Comments and recommendations are taken into consideration when the decision is made to approve or disapprove the OSCP or to require its modification.

The MMS prepares an environmental assessment (EA) on each EP submitted. Comments submitted in a timely manner are incorporated and addressed in the text of the EA or are specifically responded to on an individual basis in a section of the EA that addresses sensitive issues. The MMS action letter on an EP and associated OSCP may include conditions of approval or information to alert lessees of issues of concern that were identified through the review process but were not adequately addressed in the plan. If necessary, the MMS can disapprove an EP if issues or concerns are identified that cannot be corrected or mitigated.

Approved OSCP's are monitored by MMS to ensure that they are updated and current for continued operations. It is not uncommon for an EP and associated OSCP to be approved 6 to 12 months before the commencement of operations. In such cases, MMS reviews the OSCP before operations commence to ensure the personnel, equipment, and techniques identified in the OSCP are still available and applicable to the proposed operations. When revisions to the OSCP are necessary, the MMS requires the lessee to update the plan and make it available for public review and provides copies of the revisions to the USCG and State, if necessary. If the revision is significant, the OSCP would be redistributed for comment in the same manner as the original proposal.

E. Additional Programs for Pollution Prevention and Control: Although OCS Order No. 7 specifies requirements for pollution prevention and control, other OCS Orders and guidelines also aim to provide for safe and pollution-free operations. As an example, operators are required to use the best available and safest technology (BAST) for all activities when the MMS determines (1) that BAST is economically feasible and (2) equipment failure would have a significant effect on safety, health, or the environment, unless the incremental benefits are clearly insufficient to justify the incremental costs of utilizing such technologies. The MMS considers that compliance with OCS Orders, guidelines, and regulations constitutes BAST. The regulatory process provides for a continuous review and assessment of the equipment and technology proposed for use by lessees. These include requirements for the fitness of the drilling units, well casing and cementing, blowout-prevention equipment, mud programs, plugging and abandonment procedures, production-safety systems, well-completion and workover, pollution-control equipment, platforms and structures, pipelines, and hydrocarbon-handling and -storage equipment.

The MMS conducts a technical and environmental review of all offshore oil and gas operations. This review is conducted by staff petroleum engineers, structural engineers, biologists, geologists, and environmental scientists, who ensure that the proposed operations meet MMS-established regulatory requirements. In the review, all aspects of the proposed operation are evaluated, including the structural integrity of fixed platforms or islands, drilling operations and well control, safety systems, and production systems. An inspection program is also conducted for all OCS activities, whereby trained MMS personnel periodically inspect facilities and operating procedures. This includes the inspection of onsite and backup equipment identified in the OSCP for onshore pollution control and oil-spill response to ensure that the equipment is available and maintained in operating condition. Such MMS assurance of industry's compliance with established regulations, OCS Orders, stipulations, and conditions of approval significantly reduces the likelihood of accidental pollution.

Although the operator is primarily responsible for corrective measures, including oil-spill containment and cleanup, the USCG has the authority and responsibility to take control of the cleanup operation should the USCG predesignated On-Scene Coordinator (OSC) find that efforts by the operator are unsatisfactory. Federal oil-spill responsibilities are prescribed by the National Oil and Hazardous Substances Pollution Contingency Plan, and the USCG has established specific regional and subregional plans for Alaska. The OCS report, MMS 84-0021 Framework For Oil-Spill Response on the Alaska OCS (Allen et al., 1984), describes the framework for Federal oil-spill response and the mechanisms established for oil-spill-damage compensation. The DOI and DOT have entered into an MOU, dated August 1971, which describes each department's responsibilities regarding oil spills and loss of well control on the OCS. The MMS has been delegated the responsibility under the DOI to oversee abatement of the source of pollution. Under the DOT, the primary responsibility of the USCG is to facilitate contingency response under the national contingency plan.

F. Spill-Response Requirements for Production Operations: Spill-response planning for development and production operations will be similar to response planning for exploratory operations. The regulatory requirements previously discussed in this chapter apply to exploratory and development and production operations. There are, however, some differences between spill-response planning for exploratory operations and spill-response planning for development and production operations.

For development and production operations, the physical characteristics of the oil produced and the production flow rates of the oil will be known factors. Various oil types behave differently, and response strategies can thus be tailored to the specific oil type under expected environmental conditions. The selection of response equipment and strategies must be suitable for the oil's expected behavior under the prevailing environmental conditions.

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In addition, production operations will include transportation of the crude oil by pipeline or tanker. The OSCP must include provisions to detect and respond to a spill from these sources.

II. SPILL-RESPONSE FRAMEWORK

A. Company Organization: The following is a general description of a lessee's oil-spill-response organization for exploratory drilling operations on the Alaskan OCS. Most lessee-response efforts are organized into two distinct response levels: (1) onsite and (2) backup support.

1. Onsite Response: The purpose of the onsite-response effort, which is usually composed of personnel and equipment located at the drilling location and the lessee's support base, is to clean up operational spills and to serve as the first response effort to a large spill event. Onsite-response personnel are assigned to the drilling vessel, support boats, or barges servicing the drilling vessel. Lessee support-base- response personnel and equipment are located either at onshore-support bases within the area of operations or on a support vessel in the vicinity of the drilling operations. Examples of such support bases are Nome for Norton Sound operations, Dutch Harbor for St. George Basin operations, and Prudhoe Bay for North Slope operations. These onshore bases are centers for communications, personnel, transport services, and equipment storage. In the Navarin Basin, large supply ships and barges have been stationed near exploratory operations to supplement onshore-support facilities located in St. Paul and Dutch Harbor.

Normally, an onsite spill-response coordinator is designated to direct and coordinate initial response operations and is stationed at the drill site.

2. Backup Support: The backup-support effort is designed to supplement the onsite response by providing the additional manpower and resources necessary to respond quickly and effectively to a major spill.

Backup support usually is provided by the lessee's area-operations office and equipment from spill cooperatives and contractors within the area. For major spills, a senior-level executive heads the Backup Support Team and is given overall responsibility for cleanup operations. Members of the Backup Support Team provide direct support and coordination for spill-response efforts. This includes acquiring additional response equipment and personnel and arranging the transportation and logistics necessary to carry out a major spill-response effort. In addition, the team usually includes experts in dispersant usage, wildlife protection and rehabilitation, communications, logistics, safety, engineering, and well control. These specialists are often contracted with the company on an "as-needed" basis. Legal counsel, public relations, and governmental coordinators are also part of the Backup Support Team.

B. Onsite-Response Equipment: Onsite oil-spill-containment and -cleanup equipment for drilling operations from a floating drilling unit usually is stored either on the drilling unit or on a standby boat or supply barge. This equipment does not represent the total equipment inventory used to meet the criteria of the planning guidelines and OCS Orders; it is maintained at or in the immediate vicinity of operations for onsite-response personnel to use in dealing with small operational spills or--for larger spills--in combination with additional equipment located at the onshore-support base.

Typical onboard inventories for open-water-drilling operations from a mobile drilling vessel include 1,000 to 1,500 feet of open-ocean boom, one high-capacity open-ocean skimmer, several bales of sorbent pads and booms, and open-ocean oil-storage containers. The standby vessels and/or supply boats are used to deploy this equipment.

For operations conducted from manmade gravel islands, bottom-founded structures, or ice islands, the equipment is stored on the structure. This equipment is designed to contain and clean up spills that are most likely to occur, i.e., small operational spills of 50 barrels or less, and to serve as a first-response effort for large spills. Sometimes, small boats are stored on the island or structure for deploying the spill-response equipment when drilling occurs during the open-water season. Standby vessels and/or supply boats can also be used to deploy this equipment.

For solid-ice-drilling operations from a gravel island, typical onsite-response equipment includes rope mops, transfer pumps, sorbent pads and booms, bladder storage containers, lighting equipment, heating equipment, ice augers, chain saws, handtools, and equipment capable of scraping oil from the surface of the ice (e.g., front-end loaders, dozers, or bobcats).

For broken-ice-drilling operations, typical onsite-response equipment might also include rope mops, fire-resistant booms, igniters, sorbent materials, skimmers, storage bladders, and boom-deployment boats.

C. Spill-Response Organizations and Private Contractors:

1. Spill-Response Organizations; Alaska Clean Seas: Oil-spill-response efforts of individual companies in Alaska are supplemented by spill-response cooperative-like organizations. The spill-response organization used by most offshore Alaskan operators for exploratory operations is Alaska Clean Seas (ACS). The ACS maintains spill-response equipment and supplies to aid companies in oil-spill-containment and -cleanup operations and is organized to assist member companies in dealing with major spills. The ACS also provides for spill-response training and coordinates research efforts to improve spill-response capabilities. Individual companies pool their funds to purchase oil-spill-response equipment through ACS for each geographical area. In the event of a major spill, this equipment is available for member companies to use in their response efforts. The ACS also has developed a series of contingency planning manuals for member companies. These manuals serve as guidelines for the preparation of individual spill-contingency plans.

To date, ACS has established four major geographical areas: Beaufort Sea, Norton Sound, Gulf of Alaska, and Bering Sea. The Gulf of Alaska and Norton Sound areas are currently inactive; and, because there presently are no petroleum operations in the Bering Sea geographical area of interest (which encompasses lease-sale tracts in the St. George Basin and Navarin Basin areas), all equipment located in the Bering Sea area has been placed in long-term storage.

The MMS requires lessees to have access to ACS equipment or comparable equipment for offshore operations. Whether or not a lessee is a member of ACS, the lessee must also demonstrate its capability to meet the response-time requirements stated in the planning guidelines in order for its EP to be approved.

As new lease-sale areas open up to exploratory drilling operations, MMS anticipates that industry will organize similar spill-response organizations.

2. Other Organizations and Sources of Equipment: In addition to a lessee's onsite equipment and the jointly owned equipment of ACS, other sources of equipment are available to a lessee for a spill response.

a. Cook Inlet Response Organization: The Cook Inlet Response Organization (CIRO) is a spill cooperative for production operations in the Cook Inlet region of southcentral Alaska. As with ACS, provisions exist whereby nonmember companies can use CIRO's equipment in the event of a spill. The bulk of CIRO's equipment is stored in Kenai and Anchorage.

b. Alyeska Pipeline Service Company: The Alyeska Pipeline Service Company maintains an inventory of oil-spill equipment at their Valdez Trans-Alaska Pipeline facility and at pump stations along the pipeline route from Prudhoe Bay to Valdez. This equipment could be made available to operators throughout Alaska in the event of a spill. According to Alyeska, if a major spill occurred, a company that is a member of Alyeska could receive oil-spill equipment simply by telephoning Alyeska and requesting the use of the equipment. A nonmember company may request and use Alyeska equipment; however, Alyeska retains the right to withhold the loan of the equipment if it is needed by Alyeska or a member company.

c. Canadian Oil Companies: Canadian oil companies have established an oil-spill cooperative-like organization for their operations in the Beaufort Sea. This equipment is located at Tuktoyuktuk, Northwest Territories, Canada.

In the event Canadian-owned oil-spill equipment is needed for a response effort on the Alaskan OCS, U.S. customs requirements must be satisfied for materials brought in from Canada. In an emergency situation, the operator may obtain permission to bring in this equipment from the Chief Customs Inspector in Anchorage. The regulations governing import of materials into the U.S. for emergency use are covered in 19 CFR 10.107 (personal communication, Mr. Jim Hipsher, Chief Customs Inspector).

d. Private Contractors: Several private contractors in Alaska can provide equipment and personnel for a spill response. Two companies, Crowley Environmental Services and a.s.i. Alaska, specialize in spill-response equipment and personnel.

e. U.S. Coast Guard: The USCG maintains an inventory of oil-spill equipment in Anchorage and Kodiak. This equipment is available for oil-spill-response efforts throughout Alaska.

Most lessees have access to all of the above resources. The OSCP usually lists this equipment and includes appropriate information for obtaining the equipment necessary for a backup response. (A listing of oil-spill equipment from the above sources is included in Appendix D of this report.)

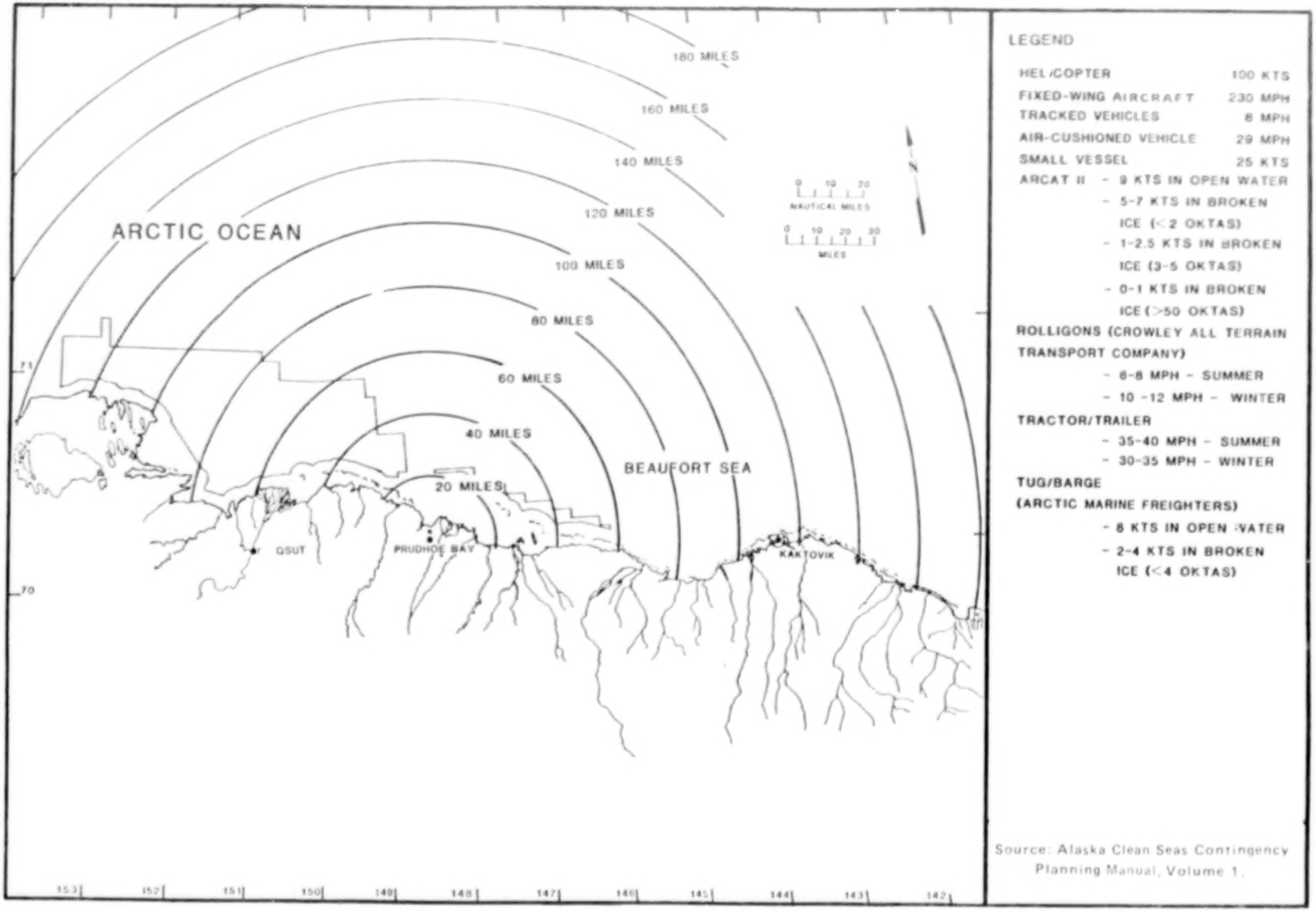
f. Petroleum Companies: In addition, several individual petroleum companies have additional inventories of spill-response equipment primarily for their own use. It has long been an industry practice for owners of oil-spill-response assets to make them available to others in an emergency.

g. Continental U.S. Oil-Spill Cooperative-Like Organizations: Additional equipment is available to Alaskan operators through oil-spill cooperative-like organizations throughout the lower 48 states, including organizations in San Francisco, Long Beach, and Santa Barbara, California, and Seattle, Washington. Most of these organizations are similar to their counterparts in Alaska; and nonmember companies can access their equipment by request, if it is not in use. Many Alaskan operators are members of these organizations as well as the equipment organizations located in Alaska.

D. Response Times: A central staging area for offshore oil and gas exploratory operations has been established for each geographical area, and ACS equipment is stored in each staging area for rapid response to major offshore spills. Nome, Dutch Harbor, Prudhoe Bay, and Anchorage have been selected as equipment-storage areas. Response times will vary depending on the mode of transport used. When the OSCP is submitted to MMS for approval, the response times are calculated and verified as part of the plan's review. Equipment can be transported to the spill site by surface vessel, helicopter, or aircraft. The response times from each staging area to the spill site can easily be calculated using the average transit speed for each type of vehicle used to transport the equipment and the distance to the spill site. Generally, 1 to 2 hours are added to these calculated times to take into account the time required to mobilize and load equipment. If the transport vessel must travel from the spill site to the staging area to obtain the equipment, the response time will increase by a factor of two. Figures 1 through 8 depict general response transit times, weather permitting, for the areas of the St. George Basin, the Navarin Basin, the Norton Sound, and the Beaufort Sea.

E. Spill-Prevention and -Response Strategies: For any exploratory operation, the first and foremost consideration after human safety is pollution prevention. The MMS has established numerous regulatory requirements aimed at spill prevention for offshore oil and gas operations; these requirements are identified in Section I of this report. Industry must comply with these requirements and often establishes a rigorous pollution-prevention program for offshore operations.

As set out in the December 18, 1980, MOU between the U.S. Geological Survey of the Department of the Interior and the USCG of the DOT Concerning Regulations of Activities and Facilities on the OCS of the U.S., MMS has full responsibility for spills originating from drilling, workover, and production operations on the OCS. The USCG regulates spills from related activities, such as fuel-transfer spills to and from a drilling unit, a supply barge, or a supply boat.



Source: Alaska Clean Seas Contingency Planning Manual, Volume 1.

FIGURE 1. DISTANCE CONTOURS FOR THE BEAUFORT SEA FROM PRUDHOE BAY, ALASKA.

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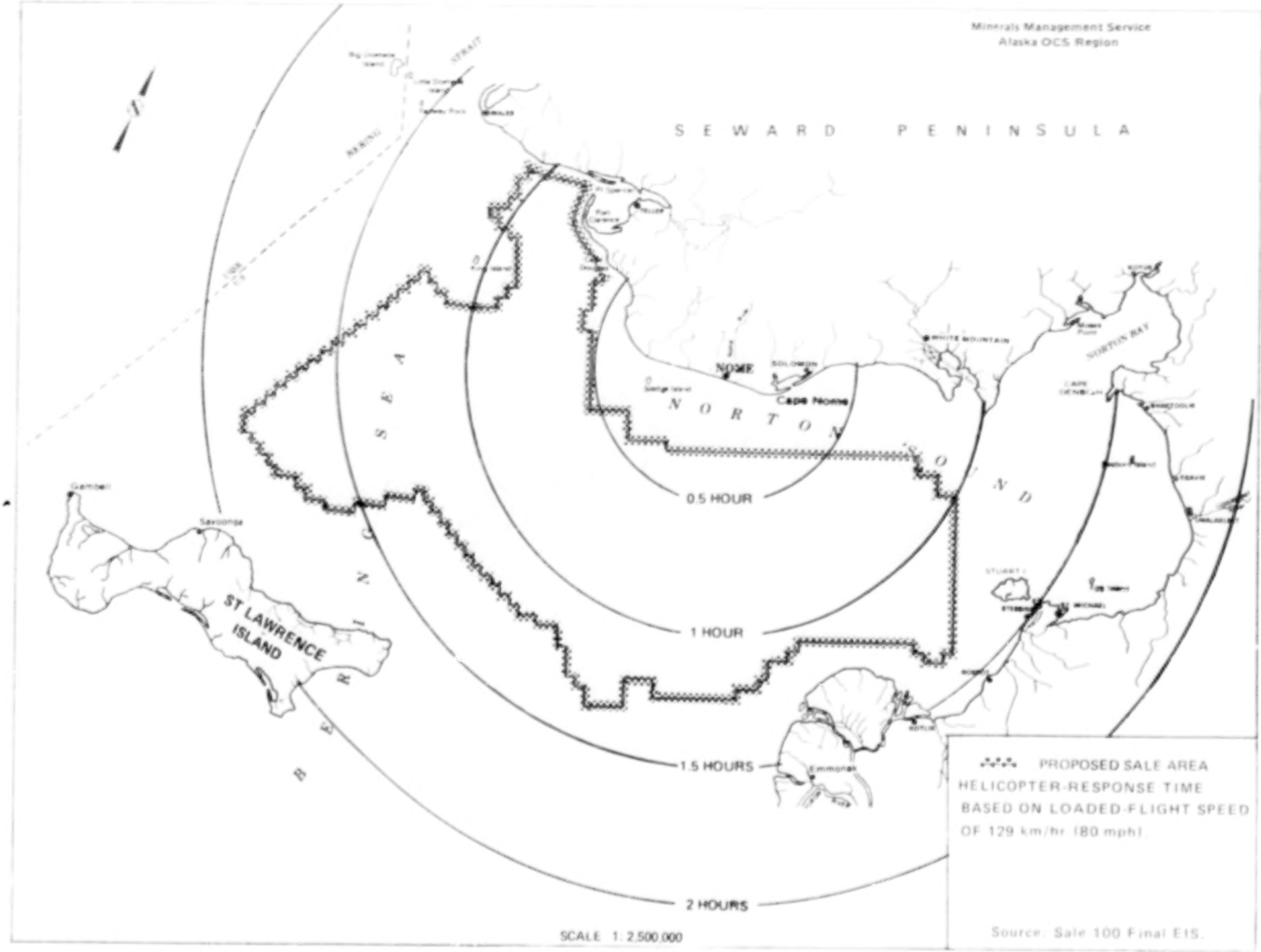

Source: Sale 100 Final EIS.

FIGURE 2. HELICOPTER–TRANSIT TIMES FOR NORTON SOUND FROM NOME, ALASKA.

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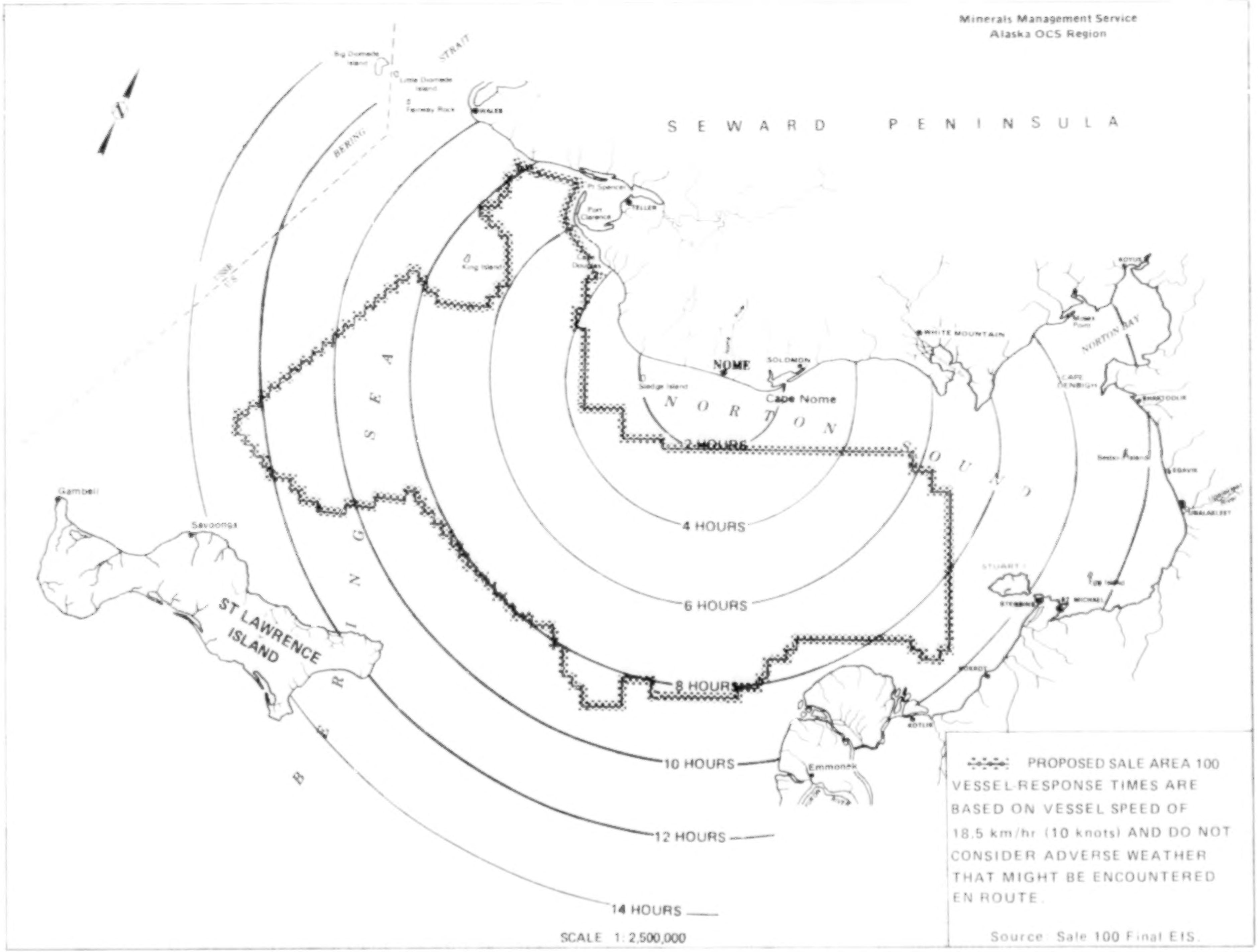

PROPOSED SALE AREA 100

VESSEL-RESPONSE TIMES ARE BASED ON VESSEL SPEED OF 18.5 km/hr (10 knots) AND DO NOT CONSIDER ADVERSE WEATHER THAT MIGHT BE ENCOUNTERED EN ROUTE.

Source: Sale 100 Final EIS.

FIGURE 3. VESSEL-TRANSIT TIMES FOR NORTON SOUND FROM NOME, ALASKA.

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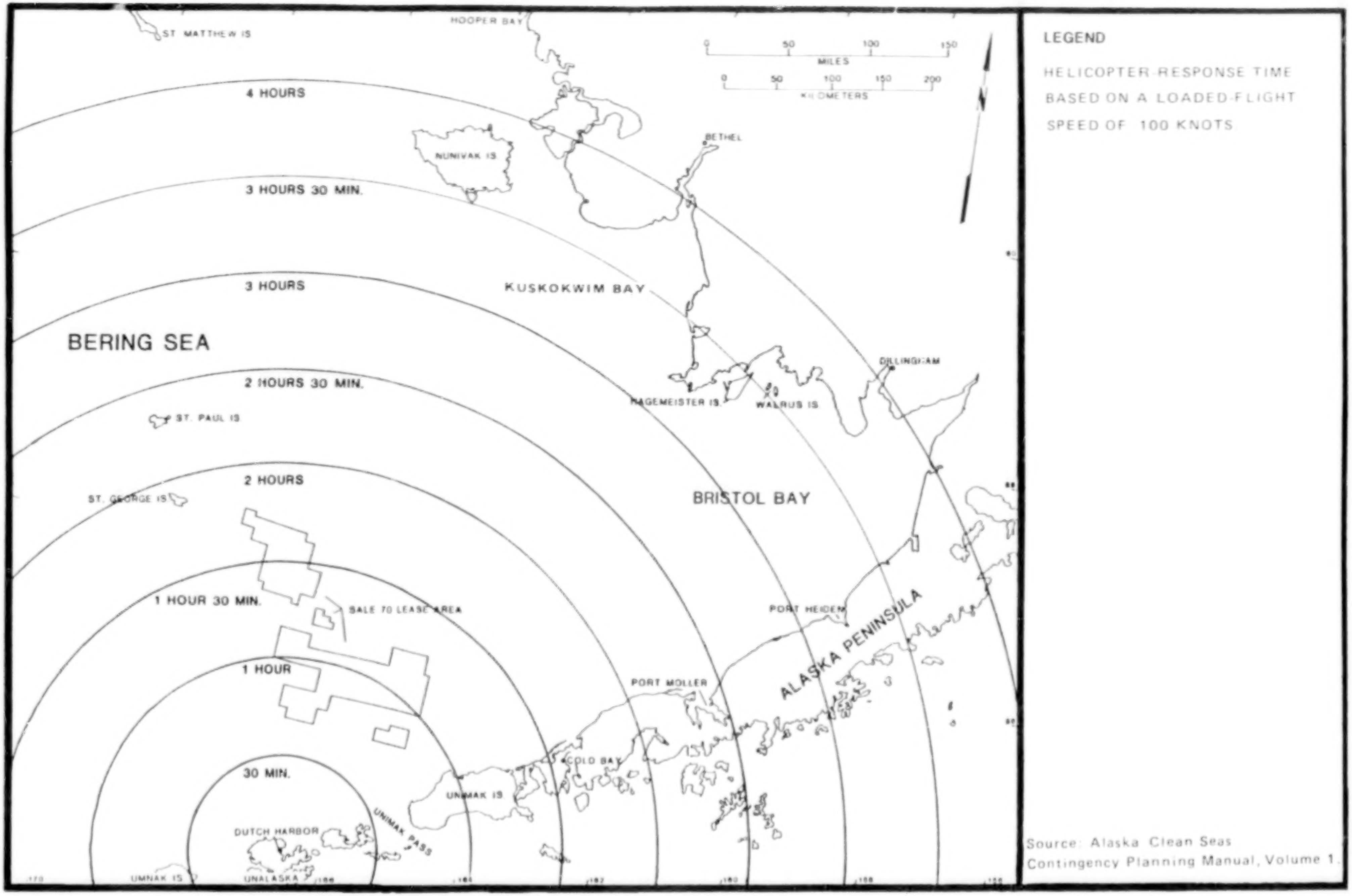

Source: Alaska Clean Seas Contingency Planning Manual, Volume 1.

FIGURE 4. HELICOPTER–TRANSIT TIMES FOR ST. GEORGE BASIN FROM DUTCH HARBOR, ALASKA.

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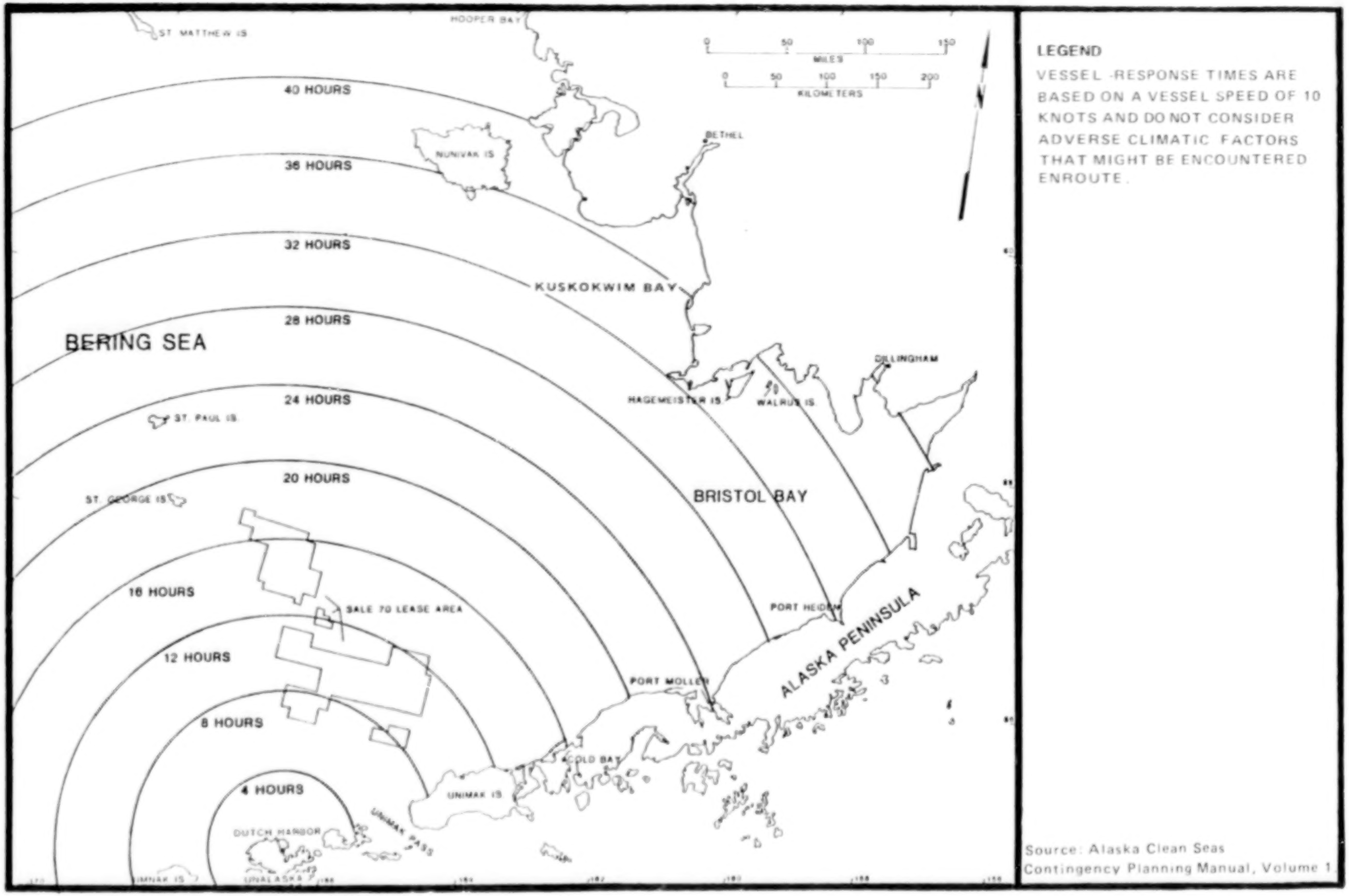

LEGEND

VESSEL -RESPONSE TIMES ARE BASED ON A VESSEL SPEED OF 10 KNOTS AND DO NOT CONSIDER ADVERSE CLIMATIC FACTORS THAT MIGHT BE ENCOUNTERED ENROUTE.

Source: Alaska Clean Seas Contingency Planning Manual, Volume 1.

FIGURE 5. VESSEL-TRANSIT TIMES FOR ST. GEORGE BASIN FROM DUTCH HARBOR, ALASKA.

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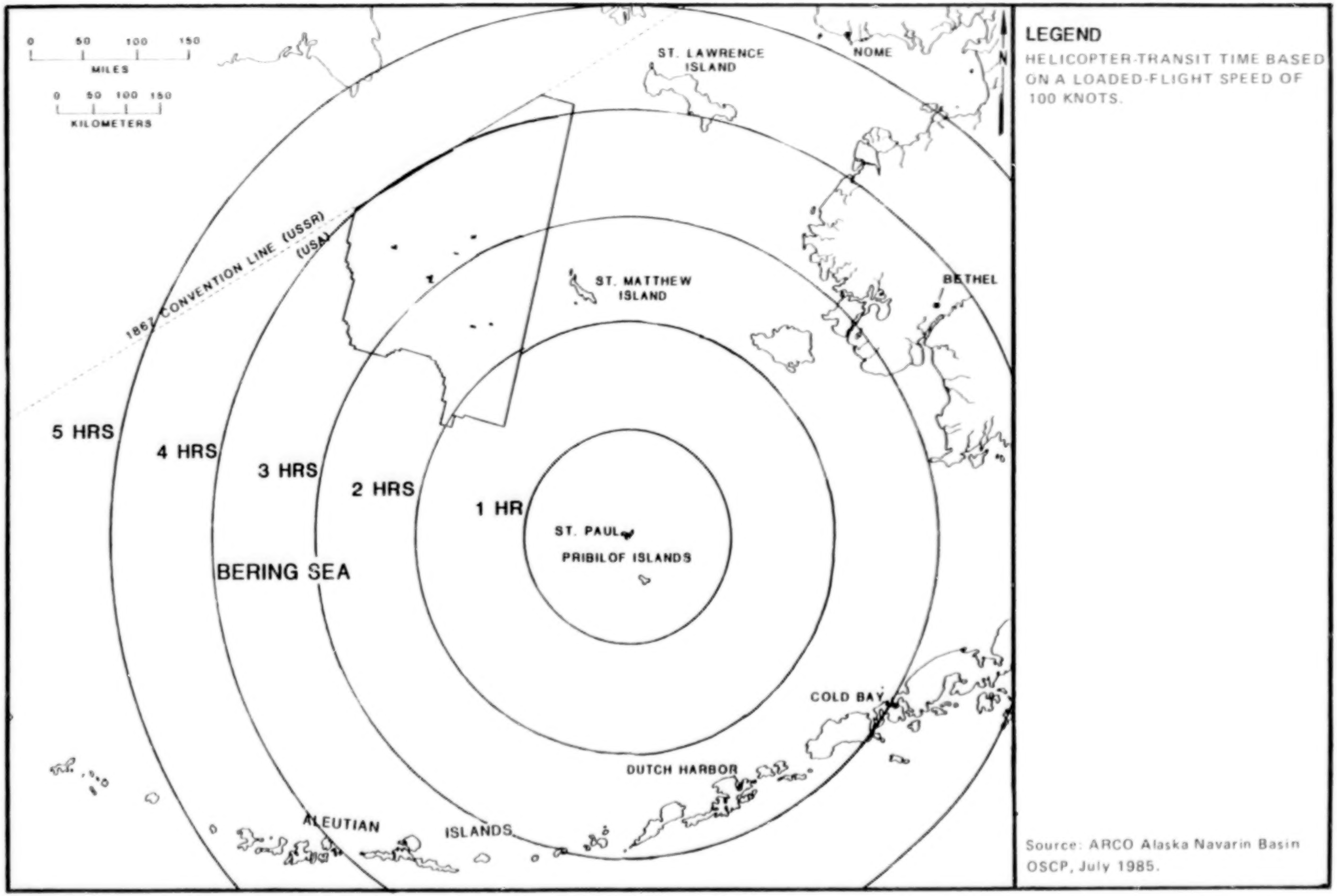

LEGEND

HELICOPTER-TRANSIT TIME BASED ON A LOADED-FLIGHT SPEED OF 100 KNOTS.

Source: ARCO Alaska Navarin Basin OSCP, July 1985.

FIGURE 6. HELICOPTER–TRANSIT TIMES FOR NAVARIN BASIN FROM ST. PAUL, ALASKA.

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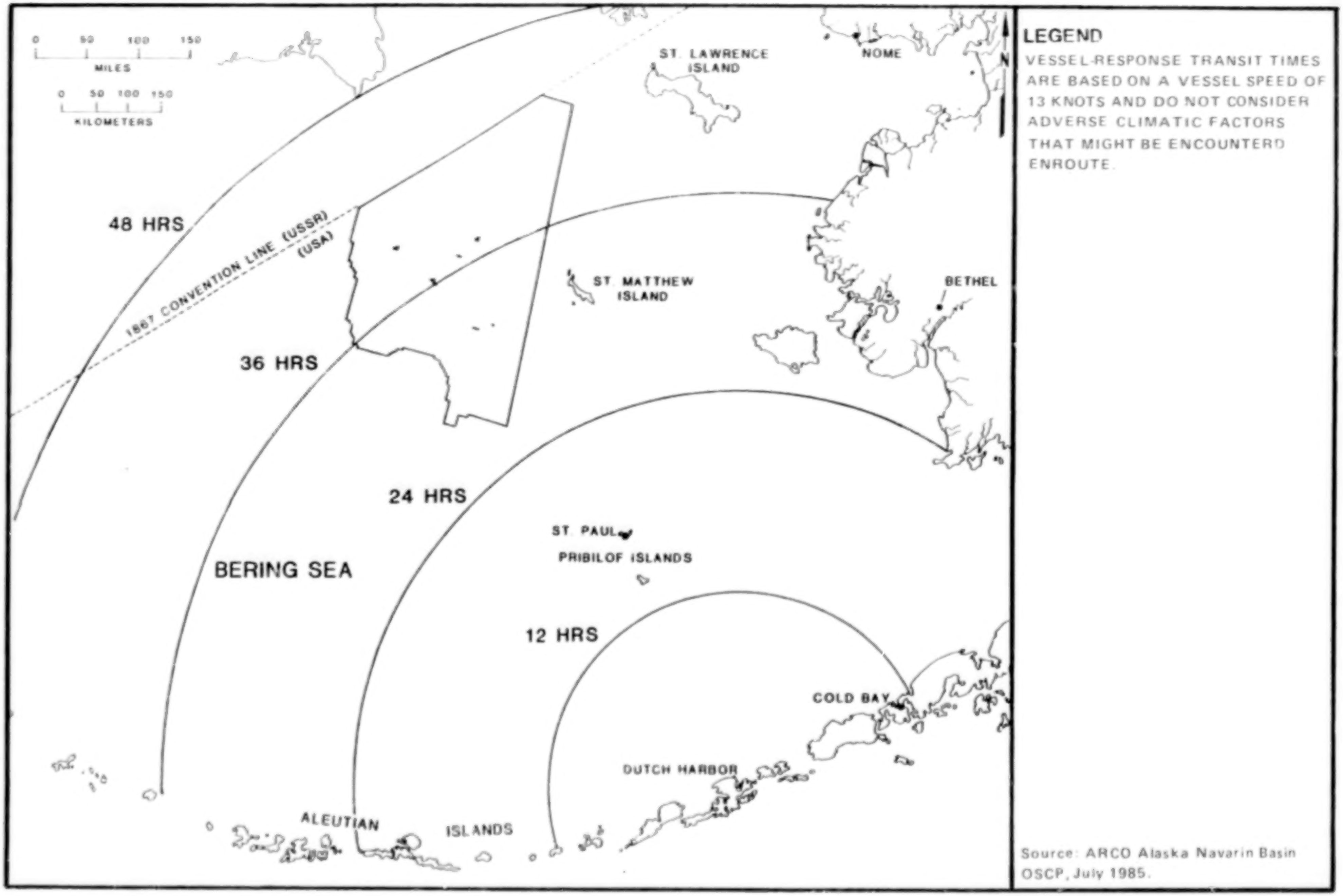

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VESSEL-RESPONSE TRANSIT TIMES ARE BASED ON A VESSEL SPEED OF 13 KNOTS AND DO NOT CONSIDER ADVERSE CLIMATIC FACTORS THAT MIGHT BE ENCOUNTERD ENROUTE.

Source: ARCO Alaska Navarin Basin OSCP, July 1985.

FIGURE 7. VESSEL–TRANSIT TIMES FROM DUTCH HARBOR, ALASKA TO NAVARIN BASIN.

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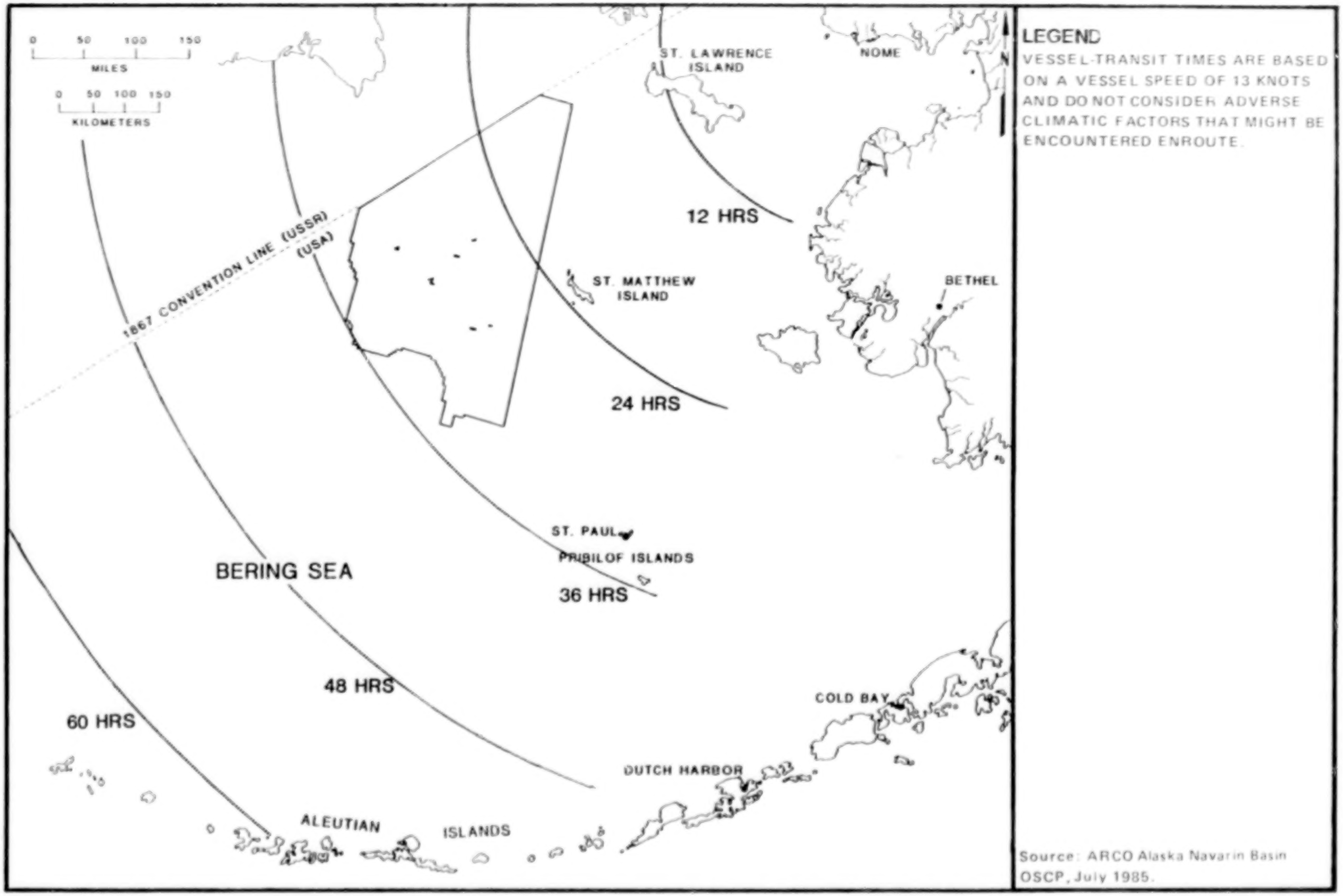

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VESSEL-TRANSIT TIMES ARE BASED ON A VESSEL SPEED OF 13 KNOTS AND DO NOT CONSIDER ADVERSE CLIMATIC FACTORS THAT MIGHT BE ENCOUNTERED ENROUTE.

Source: ARCO Alaska Navarin Basin OSCP, July 1985.

FIGURE 8. VESSEL-TRANSIT TIMES FROM NOME, ALASKA TO NAVARIN BASIN.

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Once a spill has been detected, the first measure is to determine the source and take immediate action to stop additional spillage. (In most instances, detection of an oil spill will be visual.) The next step is to alert company spill-response personnel and begin containment and cleanup, if safe to do so, using prestaged equipment with onsite-spill-response personnel. Companies are also required to notify appropriate Government agencies that a spill has occurred. The organization of spill-response teams is discussed in Section A of this chapter.

Response strategies vary for spills during open-water, broken-ice, and solid-ice conditions. The behavior of oil under each of these conditions, the type and amount of equipment available, and the logistical support capabilities dictate the appropriate response measure. Report No. CG-D-2-85, A Field Guide for Arctic Oil-Spill Behavior, developed in 1985 by ARTEC, Inc., for the USCG and is recommended as a reference for spill behavior in the arctic and subarctic.

Under open-water conditions, the spilled oil will generally form an elliptical shape. The shape is influenced by wind and currents during the initial phase of movement. Wave-action, winds, and currents will rapidly distort the slick into many different possible shapes. For open-water response, it is important to contain the slick before it is allowed to spread. Initial response actions for open-water conditions usually consist of deployment of the onsite open-ocean boom and skimmer and/or sorbent materials. Recovered oil is usually stored in portable containers or within the drilling unit. Upon approval by the USCG, dispersants may also be applied to disperse the oil into the water column.

Under broken-ice conditions, cold-water temperatures and ice can limit the spread of oil and dampen the effects of wind and wave action. In situ burning is considered the most appropriate response technique under these conditions. For broken ice, containment and recovery actions similar to open-water response can be performed in the lee of the drilling structure or unit. The lee of a structure is the side of that structure that is sheltered from the wind or current. In situ burning, either with or without a fire-containment boom, can be performed by the onsite-response personnel during broken-ice conditions. For very large spills, or spills beyond the capabilities of the onsite equipment, additional support is available through industry spill cooperatives and private contractors.

During the solid, landfast-ice period, spilled oil would be confined to a very small area surrounding the spill site, due to the roughness of the ice and the effects of cold temperatures on the viscosity of the oil. Under such conditions, most of the oil would be naturally contained on the surface of the ice. Heavy equipment and manual labor could then be used to scrape the surface of the ice to remove the oil. If oil becomes entrapped under or within the ice (should an underwater spill occur or if oil is forced under the ice through cracks by surface pooling), the primary response method would be in situ burning. In situ burning prior to and during the summer-breakup period can be performed when the oil migrates to the surface through brine channels.

The main objective in any offshore spill-response effort is to prevent the oil from damaging resources. Such damage is prevented by containment of the oil spill and recovery or removal of the oil from the water either by mechanical or burning methods. The use of chemical agents, primarily dispersants, is an alternative for breaking up an oil slick if (1) sea conditions prevent effective containment and recovery of oil at the spill site and (2) spill movement threatens shorelines or biologically important areas. A second line of defense may be set up near the shoreline or biologically important area. Efforts there will concentrate on diverting the oil from the shorelines or sensitive areas and may involve techniques to divert wildlife away from an area of contamination. Once oil has contaminated a shoreline, a third level of effort concentrates on removal of the oil and oil-contaminated materials from the shoreline. Section III of this report discusses the spill-response measures and equipment in detail.

III. OIL-SPILL-RESPONSE MEASURES

Numerous spill-response measures have been identified in OSCP's for Alaskan operations. Much of the spill-response equipment has been evaluated in test facilities, and many of the response measures have been demonstrated during field trials and oil-spill-response exercises. However, there continues to be a diversity of opinion among industry, regulatory, and environmental groups on the actual effectiveness of these response measures.

Spill-response measures can be divided into eight major categories: detection and tracking, containment, offshore recovery, in situ burning, dispersants, shoreline cleanup, wildlife protection and rehabilitation, and disposal. Before spill-response measures can be evaluated, it is necessary to understand how oil behaves when it is spilled under various environmental conditions. The various oil types and diverse environmental conditions in the arctic and subarctic allow for numerous variations of spill behavior. The USCG has recently published Report No. CG-D-2-85, A Field Guide for Arctic Oil Spill Behavior (Schulze, 1985). This report was prepared to provide Coast Guard personnel with spill-behavior information and serves as a useful reference for this MMS OCS report. It describes oil-spill behavior in cold water and under varying ice conditions and assesses the spill-retention potential of Alaskan shorelines.

The Alaska OCS Region has a weathering model that can be used to evaluate spill behavior for various types of oil under various Alaskan environmental conditions. This model was used to evaluate spill behavior during the Cepheus spill near Anchorage in January 1984 (NOAA, 1984).

Another recent publication, Oil-Spill Response in the Arctic, Part 3 (1984), was prepared by Alan A. Allen, Spiltec, for an oil-industry task group consisting of representatives from Shell Western Exploration and Production, Inc.; Sohio Alaska Petroleum Company; Exxon Company, U.S.A.; and Amoco Production Company. Additional support for the project was provided by ARCO Alaska, Inc.; Chevron U.S.A., Inc.; Gulf Oil Corporation; Mobil Oil Corporation; Phillips Petroleum Company; and Texaco, Inc. At the time of publication, this document fully described spill-response measures adopted by industry for the arctic. The document describes each response technique, assesses the applicability of each technique to varying environmental conditions, and provides the physical parameters and limitations of the equipment used for each technique.

This chapter is not intended to duplicate these efforts. Each spill-response measure is briefly described and, where appropriate, the range of effectiveness for the given technique is discussed.

A. Detection and Tracking: The first step in initiating any type of oil-spill-response action is to detect the spill. Detection of an oil spill is important in any area of the world, but it is more critical in areas where severe-weather limitations can impede such a process. In the arctic and subarctic, extended periods of darkness during the winter, the presence of ice, limited visibility due to fog and blowing snow, and logistical constraints, all complicate the task of detecting a spill. Under these conditions, visual detection is often not effective for locating a spill. As a result, industry

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and Government agencies have (1) sponsored research and have developed many new techniques for detecting a spill; (2) conducted several studies to assess the feasibility of techniques for oil-under-ice detection using acoustic and electromagnetic sensors and various remote-sensing systems for oil spills in general, such as laser fluorosensors, infrared/ultraviolet radiation imagers, side-looking airborne radar, etc.; and (3) have conducted field tests using many of these methods. Some prototype detection devices have been developed from theory and as the results of field tests. This section discusses the methodologies being researched for detection and tracking, explains briefly how they work, identifies or discusses any trials and potential uses, and discusses the limitations of each system.

1. Visual and Other Techniques for Detecting Oil Spills (Primarily Oil on Water):

a. Visual Detection: Visual observation is the most simple and direct method of detecting a spill--and the most common during operations from a manned facility. Visual detection is supplemented by preventative measures such as periodically inspecting flowlines and storage tanks; monitoring fuel-transfer operations; and observing mud-return-flow indicators, trip tanks, and mud-logging systems. Major factors that limit using visual observation to detect spills are spills that occur (1) under ice, (2) away from facilities, (3) during periods of poor weather/low visibility, and/or (4) during the night. In addition, many ocean features exist that can be confused with oil on water, including cloud shadows, ocean-surface ripples, seaweed in shallow water, and sewer discharges (The International Tanker Owners Pollution Federation, 1981). It is for these reasons that industry and Government-sponsored research has proceeded with other oil-spill-detection methods. For spills occurring in good weather conditions where visibility is not a problem, visual detection of a spill is very effective. Visual detection can be used effectively at a relatively low cost by personnel on board a drilling structure, a watercraft, or from a spotter aircraft. Once the spill has been detected and its movement predicted, an effective spill response can be initiated. Pavia and Payton (1983) describe a visual approach to observing oil at sea, including standard terminology for describing oil on the water, techniques for observation overflights, and procedures for inflight mapping of the oil-spill distribution when visual observation is possible. Accurate visual observation of marine oil spills, in this case, is necessary for effective spill mitigation.

b. Techniques for Spill Detection:

(1) Ultraviolet (UV) Radiation: Using ultraviolet (UV) radiation for detecting nighttime oil spills was reported by M.F. Fingas (1982) of the Canadian Environmental Protection Service (EPS). The concept involves the stimulation of fluorescence in the oil, yielding a white to slightly colored image on a black-water surface. Orion Electronics of Saulnierville, Nova Scotia, was contracted to develop portable equipment that used a commercially available UV lamp.

A series of tests were performed using the equipment to determine the effect of salinity, oil type, aging of the oil, viewing angle, and slick thickness upon detection. Only oil type was important, with each type emitting a

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different fluorescent appearance. According to Fingas, some of the advantages of the system include its low cost, its reliability (detection results were repeatable under similar conditions), and its ability to detect spilled oil from approximately 950 feet (289 m) with modifications of the Canadian EPS test device. One major drawback of the UV-radiation oil-spill-detection system is that the UV device is limited to nighttime use (or when the ambient-light level is less than the fluorescent output of the oil), unless a remote-sensing device is used to amplify and measure the fluorescent return (as used in other remote-sensing devices).

(2) Remote-Sensing Methods: Several remote-sensing methods are available for the detection of oil spills. These include side-looking airborne radar (SLAR), low-light-level television (LLLTV), satellite detection (LANDSAT, TIROS, NIMBUS), imaging infrared (IR) and UV systems, and laser fluorometry. Most of these remote-sensing devices have oil-spill-detection capabilities, which depend on environmental conditions such as lighting, weather, and sea states. Some are also affected by the type of oil, whether it is light-refined, crude, or heavy-refined oil. The sensors listed above have been researched and tested for their usefulness as remote-sensing devices for detecting oil spills in the marine environment and are discussed further.

Side-Looking Airborne Radar (SLAR): The SLAR systems are probably the best known for detecting and monitoring ice movements and ice coverage for arctic and subarctic locations. Extension to oil-spill detection and monitoring has been attempted. Its ability to quickly perform large-area searches and obtain real-time results; its usefulness in all weather conditions, day or night; and its reliability in detecting oil spills in open water are the major advantages of the SLAR system. Major drawbacks to using this system are (1) that dedicated, specialized aircraft and crew are required to operate the system and (2) signal suppression in the vicinity of "bright spots," including ships, icebergs, and broken ice. This signal suppression shows up on the SLAR image as a darkened area in the vicinity of the "bright spot," confusing the SLAR and appearing as a possible oil slick. Likewise, a spill in broken ice would not be detectable due to the bright return from the ice, masking the image of an oil spill.

The availability of a dedicated SLAR system would not present a major problem if the necessary equipment and personnel were on hand for monitoring ice. The SLAR flights are made in remote areas, such as the Navarin Basin (Bering Sea), to monitor ice during oil and gas operations. The same type of aircraft that is used for these remote locations would be suitable for SLAR oil-spill-surveillance flights. A further discussion of SLAR, as it relates to commercially available remote-sensing systems, is presented later in this section.

Low-Light-Level Television (LLLTV): An LLLTV is a camera device that employs image intensifiers to produce images in low-light conditions. As a remote-detection device, the LLLTV was successfully field tested as early as September 1978 at a Baffin Bay (between Canada and Greenland) oil slick believed to be caused by a natural seep. Further successful testing came later in 1978 at the Wallops test spill off the New Jersey coast. The Wallops test spill was sponsored by the American Petroleum Institute (API) with testing of various remote-sensing devices conducted by the Canada Centre for Remote Sensing (CCRS), the National Aeronautics and Space Administration (NASA), the USCG, and others (O'Neil et al., 1979).

Particular results utilizing the LLLTV were presented by O'Neil et al. at the 1979 Arctic Marine Oil Spill Program (AMOP) seminar. The LLLTV proved to be more discriminating in oil-spill detection than the SLAR systems: it was possible to differentiate oil slicks from wind "slicks," freshwater "slicks," etc. The system is capable of operating in low-light conditions, but not in complete darkness. The sensor was recently field-tested by the Canadian EPS (February 8-22, 1985), and Garrett et al. presented the results at the 1985 AMOP conference. Results from the 1985 tests showed that the LLLTV performed best under low-light, foggy, and overcast conditions. Testing also showed that when bright objects (snow, ice, etc.) were in the LLLTV's field of view, the effectiveness of the system was limited due to the reduced oil/water contrast (again, the "bright spots" mask the image) and that the system is not useful for spills in broken ice. The testing also showed limited effectiveness of the system with the "glitter phenomenon" of sun reflecting off water. This can be eliminated, as was shown in the February 1985 study, by changing the orientation of the sensor; however, this would restrict the placement and orientation of the LLLTV set up in the aircraft.

The Satellite Detectors (LANDSAT, TIROS, NIMBUS): The LANDSAT, TIROS, and NIMBUS satellite imagery have been used previously as methods of detecting and tracking oil spills. This was demonstrated during the *Kurdistan* spill (March 15, 1979), in which approximately 46,500 barrels (7,368 m^3) of oil were spilled into the Cabot Strait (Gulf of St. Lawrence) (Dawe et al., 1980), and the IXTOC I blowout in 1979. Satellite detection of oil spills relies on the use of optic sensors and is therefore plagued by overcast conditions and the requirement for daylight. The satellite must also be in a polar orbit for use in arctic and subarctic oil-spill detection. The oil-spill-detection mechanism for satellite systems appears to be sun glitter, the same phenomenon that reduces the effectiveness of SLAR and LLLTV sensor-detection methods. Oil on solid ice would tend to be easily detected by satellite imagery while oil in broken ice could give false readings. Before or if this is to become a viable detection method in arctic and subarctic regions, more research is needed concerning detection of oil as a function of oil type, ice type (multiyear, first year, etc.), and ice concentration. The main weakness of satellite detection is that the revisit time is usually too long to be useful (no real-time data).

Imaging Infrared (IR) and Ultraviolet (UV) Systems: Goodman and Morrison (1985) have tabulated the characteristics of remote-sensing systems and discussed the use of simple-imaging IR and UV cameras for oil-spill detection. The capability of the imaging IR camera as a remote sensor for oil-spill detection has been previously shown at the September 1983 Offshore Dispersant Trials off the east coast of Halifax, Nova Scotia (Goodman et al., 1984). Both IR and UV imagers successfully monitored the Uniacke blowout/condensate spill near Sable Island off Canada's east coast in late winter, 1984 (Carter et al., 1985). Monitoring of the Uniacke blowout/condensate slick was performed by CCRS. The IR and UV imagers provided useful information about the thickness and extent of the slick. Other advantages of imaging UV/IR systems include their adaptability to any small aircraft, their portability, their real-time acquisition of data (live systems with monitors), and their capability of taping images for post-flight analysis. The IR imagers can be used at nighttime while the UV's are limited to daylight uses. Both imagers are useful in overcast, foggy, and precipitation conditions. Although neither imager should be used as an independent detection device, some very useful information can be obtained from either sensor acting alone. A spill-monitoring flight would not necessarily be cancelled because of failure of one of the sensors.

The IR component of an imaging detector measures the thermal emissivity of a substance: the thermal emissivity of oil is normally less than that of water. "Bright spots" on the IR image correlate to thicker regions of the slick ("dark spots" are thinner regions). The UV images appear in just the opposite way than do IR images--thicker regions show up as dark spots while thin regions of the slick appear as bright spots. From this, it could be said that the two imagers complement each other. One drawback of the IR component is that there are potential problems with the cooling fluids and filtering systems for the IR sensor, which causes the premature shutdown of the sensor's electronics.

Oil was detected in/on broken ice by both IR and UV line scanners during the Kurdistan tanker spill in 1979. Specific examples of IR/UV images are shown in the 1979 AMOP proceedings by O'Neil et al. for the Wallops test spill (1979, off the coast of New Jersey).

An intense storm in the southern Canadian Beaufort Sea in September 1985 resulted in the erosion of Esso's Minuk artificial island and the subsequent spill of 2,440 barrels (388 m^3) of P50 diesel fuel. Birchard (1986) presents the use of an IR/UV remote-sensing system for detecting and tracking the spill. The remote-sensing device, which was mounted into Esso's Twin Otter aircraft, was successful in detecting the slick after visual contact was lost. Based on oil-spill-fate and -movement modeling and the lack of slick detection on the fourth day via remote detection, the diesel slick was assumed to have dispersed and evaporated to an insignificant stage. Esso then discontinued remote-sensing surveys at the spill site.

Laser Fluorometry: The field performance of a laser fluorosensor has previously been reported by O'Neil et al. (1980) and Capello et al. (1983). A laser fluorosensor is currently being developed for use in the Canadian offshore and arctic with system fabrication expected for 1986 and 1987, and testing in 1987 and 1988 (Till and O'Neil, 1985). The laser fluorosensor is a remote-sensing device that will be able to detect and characterize marine discharges (oil, sewage, etc.). The system being developed will consist of a pulsed, ultraviolet laser to induce fluorescence. The design emphasis of the second-generation fluorosensor, the MKIV, is on improved sensitivity with the use of recent-generation lasers. Both the MKIV and its predecessor, the MKIII, have real-time displays for direct analysis. Field testing and demonstrations of the MKIII during the 1981 Oilspill Dispersant Trials (off the coast of Newfoundland) demonstrated its ability to distinguish between seawater, chemical dye, light- and heavy-refined oils, and crude oil. According to Till and O'Neil (1985), the fluorosensor ". . .has the potential to identify the presence of oil on or mixed with sea ice." This potential

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remains to be demonstrated, and the project has been delayed by a cutback in the program funding. The system is operational both during daylight and at night. Successful development of the system should provide a compact, real-time, oil-spill-detection monitoring system that can be fitted to any aircraft.

Subsurface-oil detection is a real concern for arctic regions. There is a tendency for oil (any °API gravity) to sink below the surface of the water after some time due to weathering or migration. Discussions are ongoing between the U.S. MMS and the Canadian EPS to review the feasibility of conducting tests using laser airborne-sensing systems for detecting subsurface spills of heavy oil.

(3) Sentinel System: Recent Canadian research has investigated the potential for sentinel (permanently mounted, continuous monitoring) instrumentation for detecting oil spills from offshore platforms. A sentinel system would monitor the water surface near the offshore facility, providing an automatic alarm system for the detection of oil slicks. Research has considered infrared oil-film monitors, vapor detectors, and thermal imagers (Garrett et al., 1986)--the IR monitor illuminates the oil-water surface and analyzes the reflected radiation, and vapor detectors sense the vapor plume that evaporates from an oil slick; thermal imagers have been discussed previously. Sentinel detection systems are limited to providing information necessary to make a decision as to whether or not oil is present.

The 1986 Garrett et al. research makes the following recommendations:

- Thermal scanners (imagers) are too unreliable for use as a sentinel automatic alarm system--they require further verification before the presence of a slick can be confirmed;

- vapor detectors should be reevaluated to determine what components evaporating from the slick, if any, can be detected; and

- further evaluation of infrared monitors with controlled field testing is necessary to assess their ability to detect slicks under varying conditions.

c. Available and Potentially Available Remote-Sensor-Detection Systems:

(1) Swedish Maritime Surveillance System (SMSS): The SMSS--supplied by the Swedish Space Corporation (SSC)--was developed by conducting field-test experiments in oil-spill detection from 1972 through 1980, through a cooperative effort between the SSC and the Swedish Coast Guard. The SMSS combines several devices into an operational detection and monitoring system that has all-weather, day/night capabilities. This sensor package, placed into operation in 1981, consists of SLAR, an IR/UV scanner system, and a Polaroid component of a hand-held camera system, all of which have real-time and recording capabilities of images. Imagery (SLAR and IR/UV) from the aircraft can be transmitted by microwave to ships and land bases, as needed. The Swedish Coast Guard uses the Cessna 402C aircraft. An

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equivalent SMSS was delivered to the Dutch Coast Guard in 1982 and installed in a Cessna 404 (Fäst, 1985). Complete installation of this basic sensor package was estimated to take 4 weeks. Other sensor packages (TV camera systems, microwave radiometry, laser fluorosensor) can be added to this basic arrangement and are being integrated into the SMSS. Results from several thousand hours of flight show that the system requires minimal service and maintenance. Modularized system components allow for easy repairs, when necessary. Complete descriptions of the sensor package with actual images from one field trial are presented by Olov Fäst of the SSC in the 1985 Oilspill Conference Proceedings, pages 597-602.

(2) Aireye: White and Schmidt (1983) reported on the progress of the USCG oil-spill-surveillance system known as "Aireye." The Aireye is an advanced airborne, real-time, all-weather, day/night, remote-sensing system being developed by the USCG for inclusion in their medium-range (3.5 hours at 320 km/hr) search aircraft--the HU-25A. The system components are similar to the previously discussed Swedish Coast Guard SMSS. The Aireye system's prime sensor will be a SLAR manufactured by Motorola Incorporated, with an oil-slick-detection range capability of approximately 15 to 25 miles (24-40 km). The other Aireye sensors include IR/UV line scanners (imagers), a U.S. Department of Defense (USDOD) aerial reconnaissance camera, and an active gated television (AGTV) designed for use at low-light levels. The IR/UV sensors of Aireye, as in the SMSS, are used to scan the path directly underneath the aircraft (missed by SLAR) and to image targets detected by SLAR. The AGTV can be operated in two separate modes: (1) the passive mode for which the AGTV essentially becomes an LLLTV, or (2) the active mode where the sensor uses a pulsed laser illuminator to identify and record polluting vessels at night (White and Schmidt, 1983).

The USCG Aireye system is designed primarily to be transferred from one aircraft to another, with all the HU-25A's equipped with the necessary mounting points for all sensors, optical windows for camera systems, and consoles for the signal/image-processing equipment. Lockheed has recently proposed retrofitting the sensor package via sensor pod to the C-130 aircraft.

The Aireye system is presently undergoing final field testing and sensor adjustments while being deployed for flights out of Miami, Florida. Depending on budget constraints, the USCG anticipates deploying six Aireye systems, including one in Alaska (stationed at Kodiak), by 1987 (personal communication, USCG).

(3) Other Systems: A thermal imaging system, the Barr and Stroud IR18, is commercially available, and is complete with computerized processing hardware and software. The portable computerized system can be rapidly deployed in an "aircraft of opportunity," allows real-time image analysis from the remote thermal scanner, and has recording capabilities. The modular design of this system allows for easy maintenance.

The commercial availability of other remote sensors depends on further testing of prototype systems, such as the MKIV laser fluorosensor and the sentinal systems.

2. Detecting Oil Spills in Broken-Ice Conditions: There are many open-water features on the ocean (wake scars, kelp beds, seaweed in shallow water and freshwater, and wind "slicks") that can be confused with oil on water. The combination of SLAR, IR, and UV imagery can distinguish oil slicks from these confusing ocean features, which is one of the significant advantages of remote-sensing systems such as the SMSS and the USCG Aireye.

One major drawback affecting the remote-sensing packages presented is that they have yet to adequately demonstrate the ability to detect an oil spill in broken-ice conditions. Some of the problems concerning sensors and broken ice were discussed above as each sensor was described. The main problem is that all the systems remain relatively untested, and there is no actual experience in detecting an oil spill in ice-infested water.

The USCG attempted to use IR, black and white, and color-slide photography to detect spilled Jet A fuel associated with the January 1984 Cepheus spill in the Anchorage harbor. According to the USCG, experience with these devices was limited and mostly unsuccessful because of the lack of a standard set of IR photos of Cook Inlet without a spill and because the spill site appeared no different than the rest of the area (nothing "stood out"). It should also be pointed out that IR photography is sensitive only in the relatively near infrared region of the light spectrum (where it essentially shows reflected light). It cannot reach into the part of the IR spectrum needed for low-level thermal-radiation detection to efficiently discriminate oil on water. In order to efficiently discriminate oil on water, a line-scan imager is required, and this was not available to the USCG at the time of the spill.

The laser fluorosensor appears to hold the most promise for the detection of oil in broken-ice conditions because it is unhampered by the background conditions and measures only the presence of oil (O'Neil et al., 1980). Future testing of remote sensors should devote time to their ability to detect oil in ice.

3. Detecting Oil Under Ice:

a. Electromagnetic and Acoustic Sensors: Two categories of oil-under-ice detection devices have been researched in recent years: electromagnetic and acoustic (ultrasound) sensors. Both types are an outgrowth of devices used for measuring ice thickness.

(1) Electromagnetic Sensors: Electromagnetic sensors have been used to determine ice thickness both directly on the ice and remotely from aircraft. The basic principle of the electromagnetic-detection method is to detect radar echos reflecting off an interface, such as ice/water and ice/oil. The system already has a proven ability to detect ice thickness (Dean, 1981). The usefulness of the electromagnetic system is related to the ability of the interface to reflect a unique return signal. The signal is received at the surface and interpreted in order to determine those interface characteristics. This ability is restricted by the heterogeneous nature of the ice layer. Brine channels, brine pockets, and increased brine concentrations toward the bottom of the ice layer all cause increased signal scattering and can be misinterpreted as an interface (or can

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mask an interface). Another complicating factor is signal absorption, which is high in first-year ice, making it more difficult to recognize the return signal (Tunaley, 1985). Absorption is much lower in freshwater and multiyear ice. This complicating factor relates directly to the effect of brine on signal attenuation. Signal attenuation is much less in multiyear ice than in first-year ice. Wave interference also is a problem that occurs in thin ice of low salinity. This interference would reduce the ability of electromagnetic detection devices to distinguish between interfaces of ice/oil and ice/water.

(2) Acoustic Sensors: The acoustic method is similar to the electromagnetic system. Sound waves are transmitted through the ice medium and then reflected back from the interface. The acoustic sensor is coupled directly to the ice surface. It is very important that the signal transducer interfaces properly with the ice surface to avoid the large acoustic-impedence mismatch between air and ice. This mismatch would restrict the signal strength that is transmitted through the ice medium. Studies have shown that oil under ice behaves acoustically as a solid. A shear wave is propagated, and signal analysis of the reflected shear and compressive waves produces unique signatures when oil is present (high-shear to compressive-wave ratios) (Jones et al., 1984). In a paper presented at the 1984 AMOP conference, an experiment using the acoustic-detection method for oil under ice was discussed (Jones et al., 1984). The experimental testing was performed at the Esso Resources Canada, Ltd. (Esso) brine/ice tank in Calgary. Oil was detected under smooth ice approximately 31.5 inches (80 cm) thick. The oil thickness underneath the ice ranged from approximately 2.5 to 5.1 inches (6-13 cm). This research has led to the development of the Ultrasonic Oil Detection Instrument by Hugh Jones Associated, in conjunction with the Technical University of Nova Scotia and Orion Electronics, Ltd.

(3) Factors Affecting Usefulness: Three factors that affect the usefulness of electromagnetic and acoustic methods are (1) the need for a well-defined ice/oil interface, (2) the frequency of the transmitted signal, and (3) background "noise." A well-defined interface means that there has been minimal migration of oil into the overlying ice. Increased migration (which could happen if the oil has been under the ice for some time) creates a varying transitional ice/oil boundary that decreases the effectiveness of both methods as oil-under-ice detectors. Signal requirements for ice penetration and oil detection are competing processes for both methods: a low-frequency signal is required for ice penetration, while a high frequency is required for oil-layer resolution. This also reduces the effectiveness for these oil-under-ice detection methods. "Noise" in acoustic and electromagnetic-return signals results from cracks in the ice. The electromagnetic and acoustic signal processors must be able to extract the unique return signal from this "noise."

(4) Research: Research conducted by the Cold Regions Research and Engineering Laboratory (CRREL), Remotec, the Alaskan Beaufort Sea Oilspill Response Body (ABSORB), the Canadian Government EPS, and Esso (to name just a few) through 1984 has demonstrated the feasibility of developing a usable acoustic-detection system (Jones and Kwan, 1982 and 1983). Based on this recent research, acoustic systems appear to represent the most promise for detecting oil under ice. As an extension of the research men-

tioned, the Technical University of Nova Scotia (through EPS and Esso) developed and successfully field tested a prototype acoustic-detection device (Jones et al., 1985 and 1986). This prototype system is compact enough to be easily transported. In actual field testing of the ultrasound (acoustic) detector conducted on the Mackenzie River at Norman Wells, Northwest Territories, Canada, both ice-thickness measurements (attempted up to a 95-cm thickness) and the detection of oil under ice were accurately accomplished.

Continuing research is being conducted on problem areas with electromagnetic and acoustic detection systems such as distinguishing and extracting the "unique" return signal from background noise and determining the effects of salinity and ice thickness on oil detection under ice. Other research is being conducted to determine the portability of the systems and the repeatability of test results and to work out any problems with the systems' electronics.

Esso and the Canadian Government have completed several years of development work in acoustic detection for oil under ice. Further field testing is planned in order to establish the sensor's reliability in a wide variety of arctic conditions. The use of radio frequencies for the detection of oil under ice is being pursued at the University of Western Ontario (Meikle, 1985).

A 1986 research project, sponsored by ACS, is currently evaluating the feasibility of detecting oil encapsulated within ice and oil under ice using induced fluorescence. A prototype ultraviolet strobe and photo detector are being tested. No information was available at the time of publication of this report.

b. Airborne Radar Techniques: Research is also continuing to examine the potential for detecting oil under ice using airborne radar techniques such as Synthetic Aperture Radar (SAR). Few experimental results are available for SAR under-ice oil-spill detection. Research that will generate the necessary data to adequately assess the feasibility of using SAR for oil detection under ice should continue into the 1990's.

4. Oil-Spill-Tracking Systems: Many of the remote-sensing devices described for oil-spill detection could also be used for tracking oil spills. In addition to these devices, there are tracking buoys that could be deployed once the spill was detected and located so that the slick could be tracked. Three types of buoys were evaluated in 1981: (1) Orion 2100, (2) Orion 4800, and (3) Novatech RF200. Tests were performed off the coast of Newfoundland, Canada (near St. John's), by placing the buoys in a test slick and monitoring their movement relative to the slick centroid (Fingas and Lea, 1981). The results showed the following about the three buoys:

Orion 2100: The best overall; easy to track visually, with little deviation from the slick centroid.

Orion 4800: This buoy deviated widely from the test slick; experimenters could not locate the buoys.

Novatech RF200: There was little deviation from the slick

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centroid; however, visual tracking was difficult since the fluorescent orange skirt on the buoy quickly became fouled with oil.

A 1983 study by the USCG Research and Development Center in conjunction with Canadian Marine Drilling, Ltd. (CANMAR), a subsidiary of Dome Petroleum, was conducted to determine Beaufort Sea surface currents. The study tracked drifting buoys by satellite. Of the 10 buoys released (6 offshore Prudhoe Bay and 4 in the Canadian Beaufort), 1 failed immediately and the other 9 transmitted for up to 185 days (Robe et al., 1984). The average time-to-failure (buoy ceased transmitting) was approximately 57 days.

Three Orion 2100 tracking systems are available in Alaska through the ACS oil-spill cooperative. Each system includes at least 10 Orion 2100 tracking buoys. In 1985, ACS maintained these tracking systems at Prudhoe Bay, Dutch Harbor, and Nome for operations in the Beaufort and Bering Seas and Norton Sound, respectively. Future locations will depend on where offshore exploratory (and production) activities occur.

5. Summary: To summarize, detection of oil can be as simple as visual inspection/observation or as complex as the various methods of remote sensing. Recent research has been conducted to establish the feasibility of the various methods of detection under varying environmental conditions. Detection in remote areas, at night, in broken ice, under poor visibility, and under solid-ice cover have all been researched by industry and Government agencies. Extensions of methods used previously for other purposes such as acoustic, electromagnetic, and SLAR--to name just three--have also been applied to oil detection. Logistics can present a problem for remote areas such as the Alaskan OCS. Aircraft with extended range, short landing and takeoff, and IFR capabilities would be a necessity. Continuing research and laboratory testing have resulted in new prototype oil-detection equipment, e.g., an acoustic system for under-ice detection, a microwave radiometry system being developed for the SMSS, and the laser fluorosensor. Table 2 summarizes some important oil-spill-detection capabilities of remote sensors. One factor not considered in the table is that the sensitivity of the sensors deteriorates as sea states rise.

Results from field testing and research have been encouraging enough to continue the development of detection methods. Several remote-sensing devices have been built in recent years and offered commercially, including the SMSS discussed in this paper.

The USCG Aireye remote detection/surveillance system, although not commercially available, uses proven technology similar to the SMSS. The SLAR discussed is also available commercially and is used mainly for ice surveillance. There are no known remote-detection devices or systems (with the exception of SLAR for ice surveillance) located in Alaska at present. According to USCG officials, one of the USCG Aireye systems could be stationed in Alaska by 1988.

B. Containment: The purpose of containing spilled oil is to prevent the oil from spreading and to concentrate the oil for more efficient mechanical recovery or *in situ* burning operations. Containment of oil on

Table 2
Remote-Sensing-Characteristics Summary

CAPABILITY		LLLTV	UV LAMP	IR IMAGER	UV IMAGER	SLAR	LASER FLUORO-SENSOR	PHOTO-GRAPHY W/ UV LENS AND FILTER	LANDSAT (SATELLITE)
RELIABILITY		G	G	F 1/	F 1/	F	F	F	U
EASY TO OPERATE		G	G	F	F	F	F	F	P
REAL-TIME INFORMATION		G	G	G	G	F	F	P	P
PROVIDE IMAGE		G	P	G	G	G	P	G	G
DISTINGUISH OIL SLICK FROM OTHER FEATURES		F	G	G	G	P	F	F	U
ICE CONDITIONS		P	U	F 1/	F 1/	P	U	F	2/
OIL-TYPE DISCRIMINATION	LIGHT	G	3/	G	G	U	G	G	U
	CRUDE	F	3/	G	G	U	G	F	U
	HEAVY	F	3/	G	G	U	G	F	U
LIGHTING CONDITIONS	CLEAR DAY	F	P	G	G	G	F	F	F
	OVERCAST DAY	G	P	G	G	F	F	G	P
	TWILIGHT	F	F	F	F	F	F	P	U
	NIGHT	P	G	G	P	F	F	P	U
WEATHER CONDITIONS	CLEAR	G	P	G	G	G	F	G	F
	PRECIPITATION	G	P	G	G	F	F	G	P
	CLOUDY	G	P	G	G	F	F	G	P
	FOG	G	P	G	G	F	F	G	P

Sources: O'Neil ET AL., 1979; Garrett ET AL., 1985; Goodman ET AL., 1985.

1/ When Used Together
2/ Solid Ice-Good
Broken Ice-Poor
3/ Different Oil Types Give
Off Different Fluorescence

U-Unknown
P-Poor
F-Fair
G-Good

water in the arctic is often classified into two major categories: natural containment and containment by booms. This section discusses containment with booms. Natural containment of oil, which is most often associated with broken ice and in situ burning techniques, is discussed later in this chapter.

A boom is a barrier used to prevent the spreading of oil on the water's surface. Booms can also be used to herd oil or to protect an area from oil.

1. Boom Terminology: Most booms used to contain, exclude, herd, or concentrate oil have similar components: (1) a flotation element, (2) skirt, (3) tension member, and (4) ballast. The flotation element of a boom provides buoyancy to keep the boom riding above the water's surface. The amount of flotation material on a boom is directly related to the boom's weight. The heavier the boom, the more flotation material that is needed. The freeboard of a boom is defined as the vertical height of the boom above the water line. Freeboard prevents oil from being washed over the top of the boom; it traps the contained oil by providing resistance to the spreading force of the oil. The skirt, which is the portion of the boom below the water line, helps to contain the oil and prevents it from being carried under the boom by currents. The tension member of a boom is a structural element, such as cables and chains, used to carry loads and provide structural integrity. Ballast is a term used to describe weight that is attached to the skirt; it is often provided by a series of weights, chains, cables, or rods fastened to the skirt. Ballast improves the boom's performance by keeping the skirt perpendicular to the water surface.

Other components of booms that may be present include connectors, anchor points, hinges, and warning lights. Connectors are used to join segments of booms to one another. Anchor points are structural points on booms used for attaching anchor or mooring lines. Hinges are points on booms located between segments used to provide flexibility and to promote movement.

In describing how a boom operates in the open ocean, three processes must be considered: (1) buoyancy, (2) roll response, (3) and heave response. As stated above, buoyancy is provided by the flotation component of a boom. Buoyancy provides adequate freeboard to contain oil for recovery operations. Roll response describes the rotation of a boom from waves, winds, or currents. For best containment, the roll of a boom should be minimized. If the roll of a boom is excessive, the skirt is deflected from its vertical position--this allows oil to escape underneath the boom. To help decrease a boom's roll response, ballast is added to the skirt or the tension member. Heave response describes the vertical movement of a boom. In order to effectively contain oil, the boom must be able to follow the water's surface as it passes over a wave. Booms with this characteristic are classified as having good heave response. A boom that does not have good heave response may sink below the water's surface as a wave moves across it, causing loss of trapped oil.

Most booms can be classified in one of two categories: fence booms or curtain booms. Fence booms are made of a rigid or semirigid material that acts as a vertical barrier to floating oil; curtain booms are composed of a flexible material with a skirt held down by a tension member. The basic difference between the two types of booms is that a fence boom combines the freeboard and skirt into a single rigid piece, while a curtain boom allows the freeboard and skirt to act independently. The type of boom chosen for a spill response depends on environmental conditions. Fence booms are most often used for calm- or semicalm-water areas, and curtain booms are most commonly used for offshore areas. Booms generally are classified in accordance with their containment capabilities. Calm-water booms can be used to contain oil through an international sea state of 1 (significant wave height to 1 ft [0.3 m]), harbor booms through an international sea state of 2 (significant wave height to 2.9 ft [0.9 m]), and offshore booms with some success through an international sea state of 4 (significant wave height to 6.9 ft [2.1 m]). Other booms can be categorized by their special use, such as sorbent booms, fire-resistant booms, and ice-deflection booms.

2. Alaskan Booms: The following discusses the specific booms most commonly used for Alaskan offshore operations.

a. Model 4300 Expandi Boom: The boom most commonly available for use in offshore Alaskan waters is the Model 4300 Expandi Boom, which is manufactured in Norway by Expandi Systems AB and is distributed worldwide by Ajit Shah, Inc. This boom was chosen by most operators for recent exploratory operations in the St. George Basin, Gulf of Alaska, Navarin Basin, Cook Inlet, Norton Sound, and Beaufort Sea.

This boom is a self-inflating, curtain-type boom made of a polyurethane- pvc-type material. The manufacturer claims that the material is capable of operating from subfreezing temperatures to 165°F (74°C). Boom deployment can be accomplished from a pallet, roto pac, or reel. A tension chain is used for ballast, and internal rustproof springs are used for structural support. The Model 4300 has approximately 1.5 feet (0.5 m) of freeboard and 2.1 feet (0.6 m) of draft.

The Model 4300 boom has been deployed during several oil-spill-response demonstrations in Norton Sound, Dutch Harbor, and Cook Inlet. The response demonstrations in Norton Sound and Dutch Harbor were held during the open-water season, during the months of June and July 1984. The boom was easy to deploy and retrieve. During these exercises, the boom was exposed to approximately 2- to 3-foot seas (0.6-0.9 m). While the exercises did not involve the actual release of oil, visual observation indicated that the boom had good heave motion and resisted roll movement, and wave override was minimal.

b. Kepner Sea Curtain: Another popular offshore boom available in Alaska is Kepner Plastics Fabricators, Inc's., Sea Curtain, which has been in use since 1980 in various offshore locations from Alaska to Africa and South America (Kepner, 1985). This is a self-inflating, curtain-type boom made of a material similar to the Expandi Boom. Like the Expandi Boom, the Sea Curtain comes in four different models. According to the manufacturer, the offshore boom is capable of operating in temperatures from -40°F to 170°F (-40°C to 76.6°C) and has a freeboard of 16 inches (41 cm) and a draft of 25 inches (64 cm). The boom is deployed from a pallet or a reel, and ballast is provided by a galvanized steel chain.

An early version of Kepner's Sea Curtain was tested at the Oil and Hazardous Material Simulated Environmental Test Tank (OHMSETT)--a Government-sponsored facility located in Leonardo, New Jersey. (OHMSETT provides an environmentally safe place to conduct testing of devices and techniques used to control and clean up oil and hazardous-material spills; its main feature is a 667x65x8-foot [203.3x19.8x2.4-m] wave tank. The agencies that actively participate and fund OHMSETT research projects are the MMS, USCG, EPA, U.S. Navy, and the Canadian EPS.) The boom was tested in both catenary and diversionary modes, using No. 2 fuel oil and a lubricating stock oil. One test result showed that the boom retained test oil at tow speeds up to 1.4 knots (1.6 mph) with 2-foot (0.6-m) harbor-chop waves in the diversionary mode and 1 knot (1.1 mph) in the catenary mode under similar tank conditions (Smith, 1981).

The Kepner Sea Curtain has been used by several lessees for onsite-spill response and is an integral part of two major offshore spill-response systems available in Alaska: the Halliburton Services Fast Response Unit (FRU) and the Halliburton Open Ocean Skimming Barrier.

(1) Halliburton Services FRU: The Halliburton Services FRU--a containment and recovery system designed for use in major spill-response efforts--is composed of a self-adjusting weir skimmer attached to two lengths of Kepner boom (Halliburton, 1985). This section discusses only the boom component of the FRU. Other characteristics of the FRU are discussed in the recovery section of this chapter.

Either two or four 24-foot (7.32-m) sections of Kepner's Sea Curtain Boom are attached to the weir skimmer. This boom has an 18-inch- (45.7-cm) diameter flotation section and an 24-inch (61-cm) skirt. Ballast is provided by a ½-inch (1.3-cm) chain (Kepner, 1985). The FRU is designed for use in seas up to 5 feet (1.5 m) and at towing speeds up to 3.5 knots (4.0 mph) (Halliburton, 1985).

On August 7 and 8, 1980, the FRU was deployed offshore New Jersey, without oil. Seas ranged from 1.5 to 3 feet (0.5-0.9 m), and currents were 2.3 to 2.9 knots (2.6-3.3 mph). The Kepner Sea Curtain Boom rode the waves well; however, on a few occasions there was some water override. For the most part, the boom seemed to function well under these conditions (Nash et al., 1982).

(2) Halliburton Services Open Ocean Skimming Barrier: This barrier is another major piece of spill-response equipment in Alaska. Basically, this item is composed of a self-adjusting weir skimmer identical to the FRU's; two 330-foot (100.5-m) lengths of Kepner open-ocean boom are attached to the skimmer. The Open Ocean Skimming Barrier--designed to be towed in a "U" configuration by two vessels--is classified as a containment/skimming system. The system is expected to operate satisfactorily through an international sea state of 3 (significant wave heights to 4.6 feet [1.4 m]), based on the expected performance limitations of the boom.

c. Goodyear Aerospace Corporation Boom: The Goodyear Aerospace Corporation's 14-24 Offshore Boom is another boom used in Alaska. This curtain boom has a 14-inch (35.6-cm) freeboard, a 24-inch (61-cm) draft,

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and a skirt made of Nitrile rubber-nylon. Ballast is provided by a 0.5-inch (1.3-cm) steel chain, and flotation is provided by dual air chambers (L. Solsberg, undated).

The Goodyear boom is stored at the ABSORB warehouse in Deadhorse by the ACS oil-spill-response organization. It is also used in conjunction with the ARCAT Skimmer for the Beaufort Sea. Rated for use up to an international sea state of 3 (L. Solsberg, undated), the Goodyear boom is very durable but is extremely heavy and requires mechanical assistance for deployment and retrieval.

3. Fire-Resistant Booms: Recently, fire-resistant booms have become available for use in Alaska. Numerous fire-resistant booms have been developed, but the primary boom available in Alaska is Shell's fire-resistant boom.

a. Shell Western E&P, Inc., Fire-Resistant Boom: Developed by Shell Western E&P, Inc., this boom is composed of a series of 5-gallon (0.02-m^3) cans, which are wrapped with two layers of 70-ounce thermoglass and then covered with an abrasion-protection layer consisting of chain-link fence. The skirt, if used, is composed of neoprene. A cable plus a chain is used for ballast, and a cable is used for the tension member.

This current configuration of Shell's fire-resistant boom is the result of an evolutionary process that is still under way. As more tests on the boom are carried out, additional refinements are expected to be made to improve its performance.

Shell's fire-resistant boom has survived a 24-hour test burn in a test tank without significant degradation. It was tested at Shell's wave-tank facility in Houston, Texas; and, according to Shell, it is capable of containing oil in up to 2-foot (0.6-m) seas. During the summer of 1985, the boom was successfully deployed off of East Dock, Prudhoe Bay, into the Beaufort Sea under harbor-chop conditions with winds averaging 25 miles per hour (40.2 km/hr). The boom was observed to have good heave response and to resist roll movement. Oil was not used during this test.

b. 3M Fire Boom Blanket: The 3M Fire Boom Blanket has also recently been developed. This product, which is wrapped around a normal containment boom, protects the boom from fire and heat during in situ burning. ACS burn tested the 3M system (surrounding a Kepner boom) in a tank for 24 hours, and it remained flexible and useable after testing. The key component of the blanket is 3M's #312 Nextel ceramic fiber (Marine Digest, 1985), which is coated with neoprene to improve abrasion resistance. The blanket can withstand fires up to 2,000 degrees Fahrenheit (1,092°C) and comes in 25-foot (7.6-m) lengths with widths of either 36 inches (91.4 cm) or 48 inches (122 cm). The 3M blanket is commercially available through Crowley Environmental Services in Seattle, Washington. Tow tests were conducted on the blanket in Puget Sound, Washington, in June 1985 (Oil Spill Intelligence Report, 1985). Results showed that the blanket apparently did not affect the performance of the conventional boom to which it was attached. Shell Western E&P, Inc., has purchased 1,000 feet of the 3M Blanket Boom System for their operations in Alaska.

c. Kepner FireGard: Another new fireproof boom, FireGard, is manufactured by Kepner Plastics Fabricators in Torrance, California. According to the Oil Spill Intelligence Report (Vol. VIII, No. 42, 1985): "The FireGard boom has undergone testing at Texas A&M University and withstood a fire at over 2000°F (1,092°C) for more than eight hours with negligible damage."

The FireGard is similar to Kepner's Reel Pak Sea Curtain boom in that it is stored and deployed on a reel. It has a flexible, high-temperature cover that can be removed and replaced if damaged, and it is available in three standard models: the inland choppy-waters model with an 8-inch- (20.3-cm) diameter float, the open-harbor model with an 11-inch- (27.9-cm) diameter float, and the light-ocean model with a 14-inch- (35.6-cm) diameter float. Flotation is provided by a continuous series of stainless-steel coils inside the boom. Apertures through the boom's covering allow the passage of water inside the boom, which provides cooling during burning operations. While the major application of this boom will be to contain oil for burning operations, Kepner notes that it could be used for nonburning containment operations.

d. Additional Information: For further information on fire-resistant booms, including Shell's Fire-Resistant Boom, 3M's Fire Boom Blanket, and Kepner's FireGard and other fire-resistant booms, see Spiltec's "Test and Evaluation of Fire Containment Booms," February 1986.

4. Boom Testing and Effectiveness: The effectiveness of booms to contain oil for recovery operations or to divert oil as a protective measure will vary greatly, depending upon the specific environmental conditions during the operation. Many booms have been tested in wave tanks in an attempt to characterize their performance under various wave and current conditions. However, wave tanks are limited by scale and may not truly represent offshore conditions. Offshore tests with booms and oil have been extremely limited and often lack proper scientific test procedures and accurate documentation of the environmental parameters during the test. In offshore testing, visual observation has been the primary method used to compare one boom's performance against another's.

In 1977 in the Gulf of Mexico, the USCG conducted offshore tests of six booms (USCG Open-Water Containment System, Sjuntorp Coastal Boom, Vikoma Seapac System, Bennett Inflatable Offshore Boom, Whittaker Expandi Oil Boom, and B.F. Goodrich 36-inch Sea Boom) (Corpuz and Griffith, 1978). Although oil was not used in the test, each boom was visually observed for its seakeeping ability. One of the booms used during this test was an early version of the Expandi Oil Boom. The boom was moored in a "U" shape and experienced waves up to 3 feet (0.9 m). Some containment failure was noted by splashover, washover, and washunder during seas of 2 to 3 feet (0.6-0.9 m). Several of the booms suffered serious mechanical failure and could not be thoroughly evaluated.

One boom, manufactured by Offshore Devices, Inc., was subjected to severe conditions with significant wave heights of 8 to 10 feet (2.4-3.1 m) without mechanical failure. During the 8-day test of the Offshore Devices Boom, signs of containment failure were only occasionally observed.

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In 1980, Environment Canada conducted tests of six offshore booms (MacAllister/AMOP Boom, Troilboom, Albany Oilfence, Versatile Environmental Products Zoom Boom, Vikoma Seapac, and USCG Boom) under severe weather conditions in the North Atlantic. A small amount of oil (1-2 bbls [0.16-0.32 m^3]) was released into each boom, and visual observation was used to determine the length of time required for the oil to be lost by the boom. The results were not conclusive.

One boom, the Vikoma Seapac, is used by the Cook Inlet Response Organization (CIRO) and Alyeska Pipeline. The other booms are not currently maintained in Alaska. During these tests, the Vikoma Seapac contained two-thirds of the oil after 45 minutes, under a 4- to 6-inch (10.2-15.2-cm) wind chop on top of a 6-foot (1.8-m) swell (Purvis et al., 1980).

These tests demonstrate that offshore booms cannot, under dynamic conditions, be expected to contain 100 percent of oil over any length of time.

Another source of effectiveness regarding a boom's containment capabilities is through actual use on offshore spills. In nearly all cases, containment by booms was judged ineffective in all but calm- to moderate-sea conditions (seas less than 5 ft [1.5 m]). Under these circumstances, effectiveness is based on visual observation.

Booms, however, can be an effective response tool even if they only partially contain the oil--this is often the case when they are used in conjunction with an advancing skimmer. The purpose of connecting a boom to an advancing skimmer is to increase the amount of oil encountered by a skimmer over a given period of time. In doing so, a boom is positioned at an angle to the forward motion of the boom/skimmer system to divert oil to the skimmer. When used in this manner, booms can be considered an effective tool in seas higher than 5 feet (1.5 m).

Increasing waves, sea states, and currents will decrease the amount of oil a boom can contain because of wave override and oil escape beneath the boom's skirt. Generally, as the sea states increase, a boom with a larger freeboard will provide better containment than a boom with less freeboard and/or draft. In addition, a boom that conforms to the motion of the water's surface results in more effective containment.

In summary, the effectiveness of offshore booms currently in Alaska is based primarily on qualitative observations; there is very little quantitative test data. While the qualitative results that are available cannot be used to establish definite numbers regarding the percent of oil contained versus sea state or time, they may be useful for comparing one boom's effectiveness against another's. Containment booming has been shown to be an effective response technique under calm conditions and is useful offshore in international sea states up to 4 (6-ft [1.8-m] seas). In higher sea states, containment booming is generally considered neither practical nor effective. The OHMSETT has begun a 2- to 3-year offshore-testing program for booms. The purpose of this program is to establish a formal test protocol for offshore boom. Two booms--an Expandi Boom and an Oil Fence--were fully instrumented and deployed in the Atlantic in mid-1986; and the results of these tests will be published later this year. Future boom tests will use oil to verify instrumented test results. This testing should provide much-needed information regarding boom performance in higher sea states.

Very little work has been done to evaluate the use of booms in broken ice. Most booms are not expected to be capable of surviving ice forces. Some booms may have limited use in a free-floating mode for in situ burning, and others may be suitable for use in conjunction with an ice-deflection system. Further work will have to be carried out in these areas before accurate statements can be made about their uses and effectiveness.

5. New Technology: New technologies that show promise in the field of containment are the high-pressure waterjet, bubble barrier, and acoustic-herding systems. The bubble barrier and acoustic herders may also have applications in the in situ burning of oil.

a. High-Pressure Waterjet-Barrier System: The waterjet technique uses high-pressure water streams to move oil over the water's surface and herd it for recovery operations. The high-pressure, high-velocity water streams break into a fine mist, entraining a large amount of air and resulting in a thin, horizontal airjet over the surface of the oil. This horizontal flow of air moves the oil over the water's surface the same way natural wind does.

The waterjet concept was explored in a series of tests conducted at the OHMSETT facility in 1982. The system tested consisted of three jets manifolded together and clamped onto the main towing bridge in the test tank. The manifold was hooked up to either a single or a dual pump.

The results of the tests on the waterjet-barrier system demonstrated that the waterjet technique will move oil on the water's surface. Problems identified during the tests that need further research include determining the optimum angle of the jet, the height of the jet above the water's surface, and optimum pressure and flow rate (Meikle et al., 1985).

At present, two waterjet barriers have been designed for further testing. One is designed for retaining floating oil and the other for moving oil. Both systems are mounted on a floating platform and are connected to a vessel of opportunity containing a pump. In August 1984, the waterjet barrier was tested on the Mackenzie River in Norman Wells, Northwest Territories, Canada. The tests used peat moss treated with vegetable oil to simulate crude. Containment-mode tests of the barrier showed that the waterjet was superior to conventional booms as a deflection device under test conditions. One of the tests showed that the waterjet could maintain an oil-herding configuration in currents up to 2 knots (2.3 mph).

The outlook for this system is good. Its possible uses include application to broken ice and shorelines. Meikle et al. (1985) state that more testing is needed to determine the capability of the barrier to contain oil in ice-infested waters.

b. Bubble Barrier: The bubble barrier is a device that emits a column of air from below the water's surface. When it reaches the surface, the air column creates a horizontal current that will move any oil that is

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present. If the force generated by the air column is equal to and opposite of the force generated by the surface current, the oil on the water's surface will be trapped in a stationary oil front. This stationary oil front can then be burned.

The bubble barrier shows promise for effectively containing/burning oil in the dynamic broken-ice conditions of the Beaufort Sea of Alaska's North Slope. The force of the current created by the barrier on the water's surface is strong enough to restrain a spreading oil slick, but it is not strong enough to resist the movement of large pieces of broken ice. This system may allow oil to be contained for recovery while it separates the larger pieces of moving broken ice by not restraining their movement.

A 500-foot (152.4-m) prototype bubble barrier fabricated by Exxon is currently undergoing tests through the ACS research program. This system consists of an air compressor attached to a ballasted, porous canvas hose. This prototype model was tested in a pond, and its ability to contain oil was studied. The submerged canvas hose is maintained at a proper depth by tether lines attached to individual floats. A fiberglass stiffener is used to keep the hose in line. Based on initial results, the bubble barrier shows promise for use during broken-ice conditions, providing the ice can satisfactorily ride over the top of the submerged hose.

Exxon carried out other tests that dealt with burning the contained oil to see if the barrier would sustain any damage and reported no damage on any of the burn tests. When used to contain and burn oil, the bubble barrier acts as an effective fireproof boom. However, further testing needs to be carried out--especially in waves, currents, and floating ice--to determine if the bubble barrier can act as an effective containment/burning barrier in an arctic offshore environment (Williams, 1985).

c. Acoustic Herding: The OHMSETT is proposing to test an acoustic herder at their test facility in 1987. The acoustic herder, which uses sound to herd oil, may have the potential to herd oil but not ice.

Other recent advances in containment technology are the development of ice booms (Schulze, 1985). Dome Petroleum Ltd. and Troilboom have each manufactured a boom that they say can contain oil in light-ice concentrations. The Dome boom has a solid flotation chamber inside a "V"-shaped skirt so that ice can be deflected without causing damage to the boom. The Troilboom is a fence boom with an external tension member and an ice-catching net. The net collects drifting ice but permits spilt oil to drift back to the boom for containment. These booms are not presently in use in Alaska, and little is known about their effectiveness under broken-ice conditions.

C. Offshore Recovery

Recovery is defined as the mechanical removal of oil from water or ice environments. For oil on water, recovery techniques can be divided into two groups: the use of skimmers and the use of sorbents. For oil on ice, manual recovery is the primary method. For oil under ice and oil in broken ice, a combination of the above techniques is used. Because in situ burning is not generally regarded as a recovery technique, it is discussed separately in this report.

Sorbents are made of oleophilic materials designed to absorb up to 30 times their weight in oil. They come in many forms, including pads, booms, rolls, pillows, and sweeps. Sorbents are primarily used to recover small amounts of oil and thin films of oil from the water surface. They are very effective in removing refined products such as diesel fuel, but they also can be used for most types of oil. Other applications for sorbents include using them for spills in small melt pools, on shorelines, and around industrial equipment; and they also have been used to recover burn residue after in situ burn testing.

1. Skimming Systems:

a. Types of Skimmers: Skimmers are mechanical devices designed to float on the surface of water and recover oil. They are generally categorized as suction devices, weir devices, centrifugal devices, and oleophilic devices. Some skimmers use a combination of these principles and are classified as hybrids.

(1) Suction Skimmers: Suction skimmers float on the water's surface and use a vacuum pump system to recover fluids that come into contact with the skimmer's inlet. They are suitable for use where oil is highly concentrated--in calm water, in leads, or in pools on the surface of ice. Suction skimmers tend to draw debris, which may temporarily plug the skimmer, and are not suited for use in the presence of brash ice or areas where a high ratio of debris is present in the oil. Several suction-skimmer systems are currently maintained in Alaska.

(2) Weir Skimmers: Weir skimmers are devices that use a weir to separate the oil from the water. The oil flows over the weir to a sump and is then pumped to a collection vessel. Weir skimmers are very effective in calm water. Wave action tends to increase the amount of water collected by the system.

(3) Centrifugal Skimmers: Centrifugal skimmers rely on the centrifugal force furnished by the tangential entry of the oil/water mixture into the skimmer to separate the two fluids. The oil is concentrated in the center of the skimmer and is drawn off through the top exit port by a pump for collection. The water exits through the bottom port into the sea.

(4) Oleophilic Skimmers: Oleophilic skimmers contain a surface to which oil will adhere instead of water when the skimmer is placed into an oil/water mixture. The oil is removed from the surface by a wiper or ringer, collected in a sump, and then pumped to a storage vessel. Oleophilic skimmers generally have a much higher oil-to-water recovery ratio than other skimmers.

b. Skimmer Effectiveness: The effectiveness of a skimmer depends on the characteristics of the oil, slick thickness, oceanographic conditions (especially sea state), oil-encounter rate, through-put efficiency, and recovery efficiency. As a general rule, optimum efficiency is reached when the slick is thick and the sea state is calm. In cold water, the increased viscosity of heavy oils reduces the effectiveness of many weir skimmers and can prevent effective operation of vacuum systems and pumps.

Oleophilic skimmers and Destroil pumps work quite well for high viscosity oils, providing the oil will flow.

c. Skimmer Availability and Classifications: The oil-spill cooperatives and individual companies maintain a variety of skimmers for response operations offshore Alaska. They are often classified in accordance with their uses as portable skimmers, vessel-of-opportunity-mounted skimming systems, and skimming vessels. Industry's Oil Spill Response in the Arctic, Part 3 (Spiltec, 1984), describes the use and physical parameters of these systems and is recommended as a useful reference.

(1) Portable Skimmers: Portable skimmers available in Alaska include oleophilic skimmers (including rope-mop systems and disc skimmers), weir skimmers, and some hybrids.

Rope-Mop Systems: Portable rope-mop systems come in various sizes and capacities, from small, drum-mounted models with a maximum recovery capacity of 15 to 30 barrels (2.4-4.8 m^3) per hour, to large, skid-mounted models with a maximum recovery of 200 barrels (31.8 cubic m^3) or more per hour (Oil Spill Intelligence Report, Directory of Oil Spill Control Products, 1985). The small, drum-mounted systems are commonly located at drilling facilities as immediate spill-response skimmers for operations from gravel islands and structures in the Beaufort Sea. Large rope-mop skimmers are available as backup for large spills from numerous operators and Alaskan cooperatives.

Rope-mop skimmers are well-suited for oil-spill-recovery operations under cold conditions and have been successfully used for spills in the arctic. During the No. 2 fuel-oil spill in Buzzards Bay, Massachusetts, rope mops were effectively used during broken-ice conditions. Rope mops have been deployed for demonstration purposes under varying conditions in the arctic, including deployment (1) from barges during broken-ice conditions, (2) from gravel islands during open-water and broken-ice conditions, (3) in melt pools, and (4) in slots cut in the ice during the winter months. The mops are simple in design and easily adapt to most arctic conditions.

Tests of rope mops at OHMSETT indicate that recovery efficiencies range from 50 to 80 percent in 2- to 3-okta-ice coverage. (Recovery efficiency is defined, for the purpose of this report, as the percentage of recovered liquid that is oil.) Oil-recovery rates for rope-mop-system tests at OHMSETT ranged from 20 barrels per hour to over 120 barrels (3.2-19 m^3) per hour. The tests were conducted on seven rope-mop-skimming systems using light, medium, and heavy oils, with slick thickness ranging from 3 to 9 millimeters (.12-.35 in.) (Griffiths, 1985).

Disc Skimmers: Disc skimmers also are available and have varying recovery capacities. One of the common disc skimmers in use in Alaska is the Komara Mini Skimmer. The manufacturer rates the recovery of this skimmer up to 66 barrels (10.5 m^3) of oil per hour. When tested at OHMSETT in 1975 and 1976 with a Spate pump, the recovery efficiency ranged as high as 99 percent, with oil-recovery rates up to 12 barrels (2.4 m^3) per hour under calm conditions and an oil viscosity of 18 centistokes at 79°F (26°C).

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Weir Skimmers: Various portable weir skimmers also are located in Alaska. Two common weir skimmers, the Self-Leveling Unit for the Recovery of Pollutants (SLURP) skimmer and the Acme skimmer, are reported by the manufacturers to recover from 50 to 390 barrels (7.9-62 m^3) per hour, respectively. Such high recovery rates would be possible only in areas where oil has been highly concentrated and are not likely under offshore conditions.

Walosep Portable Skimmer: One portable skimmer, the Walosep, has become quite popular for offshore exploratory operations in the Bering Sea. The model used in Alaska is the Walosep W1. The Walosep uses a combination of weir and centrifugal actions to recover oil. The manufacturer states that the Walosep W1 can operate in 10-foot (3.1-m) seas and has a maximum recovery capability of 189 barrels (30 m^3) of oil per hour. Walosep also manufactures a larger model--the W3. The manufacturer rates the W3 at 629 barrels (100 m^3) of oil per hour. The Walosep has been tested offshore with heavy, emulsified oils. A test was conducted on the W3 in waves averaging 7 feet (2.1 m), with a period of 5 seconds. The skimmer recovered 175 barrels (27.8 m^3) of the emulsion in 1.5 hours with a recovery efficiency of 65 percent (Ajit Shah Inc., 1985).

The Walosep has also been tested in the OHMSETT facility under various current and wave conditions, with both light and heavy crudes. Total oil volume presented to the skimmer over the 4-day test period was approximately 243 barrels (38.6 m^3) in slicks ranging from 0.04 to 2.0 inches (1-50 mm) thick. Recovery efficiencies ranged from 33 percent to over 96 percent, with recovery rates ranging from 32 to 570 barrels (5-91 m^3) per hour. Current speeds ranged from 0 to 0.50 knots, with wave conditions from calm to 1.6 feet (0.5 m) in height (Ajit Shah, Inc., 1985).

In a large, continuing offshore spill, the Walosep would most likely be used in a stationary mode in the apex of a boom downwind of the source. Under such conditions, the oil slick would be thick and would have a dampening effect on the sea states. In one test at OHMSETT, the Walosep was used in a stationary mode under turbulent wave conditions, with a slick thickness of 1.97 inches (50 mm), using Circo heavy oil. Under these conditions, the recovery efficiency was 97 percent, and the oil-recovery rate was 343 barrels (54.5 m^3) per hour (OHMSETT Test Data, 1979).

(2) Vessel-of-Opportunity Skimming Systems: The oil-spill cooperatives in Alaska maintain several large vessel-of-opportunity-mounted skimming systems, including the Spilt Oil Containment Kit (SOCK) Skimmer, the Halliburton FRU, and the Halliburton Open Ocean Skimming Barrier. These systems are designed to be operated from a large vessel of convenience such as an offshore-rig-supply boat. These skimming systems are usually deployed in a nonstationary mode.

SOCK Skimmer: The SOCK Skimmer is a modified bag suction/weir skimmer. The SOCK is 43 feet (13.1 m) long, 25 feet (7.6 m) wide, and includes a 200-barrel (31.8-m^3) storage container. It is currently located in Dutch Harbor but can be transported by C-130 aircraft to other locations in Alaska. The SOCK has been tested in the open ocean by OHMSETT personnel and is capable of recovering 220 barrels (35 m^3) of oil per hour for oil thickness on the order of 0.09 inches (2.5 mm), at skimming speeds from 1.2 to 1.6 knots. Recovery efficiencies of up to 90 percent were obtained under optimal conditions (Nash et al., undated).

The SOCK was used during the 1977 Ixtoc spill in the Gulf of Campeche. Full-scale tests were done on a prototype of the SOCK over a 5-day period. Typical oil-recovery rates during the tests were on the order of 200 to 250 barrels (31.8 to 39.8 m^3) per hour of an oil/water emulsion with viscosities ranging from 1,200 to 4,000 centistokes. Oil thickness was typically 0.08 inches (2 mm). The SOCK recovered very little free water under these conditions. The manufacturer reports that no performance degradation was observed in seas up to 4 feet (1.2 m), and good performance can be expected in seas up to 8 feet (2.4 m) (Fraser et al., undated).

Halliburton FRU: The Halliburton FRU is composed of a floating weir-skimming system connected to two short lengths of Kepner boom. The system is deployed alongside of a vessel of opportunity and is held in place by an outrigger. It also contains a 90-barrel (14.3-m^3) recovered-fluid storage tank and hydraulic power pack for deployment and storage. Sweep width of the boom is 30 feet (9.14 m). The system has been tested at OHMSETT under varying conditions with both heavy and medium oils. The tests showed that throughput efficiencies ran as high as 100 percent for speeds of 1.25 knots, with an oil-recovery rate of 293 barrels (46.6 m^3) of oil per hour in a slick that was 0.08 inches (2 mm) thick. Much higher oil-recovery rates are possible in thicker slicks. The skimmer was tested under severe harbor-chop conditions of 2 feet (0.6 m), resulting in throughput efficiencies of 70 percent.

The manufacturer notes that the FRU is designed for operation in seas of up to 5 feet (1.5 m) (Halliburton, 1985).

Halliburton Open Ocean Skimming Barrier: The Halliburton Open Ocean Skimming Barrier is essentially a boom towed in a "U" configuration between two vessels of opportunity using a weir skimmer at the apex of the boom for oil recovery. The weir skimmer is identical to the skimmer used in the FRU. The skimming barrier utilizes approximately 670 feet (204 m) of Kepner Open Ocean Boom that is bridled near the apex. With an opening of approximately 150 feet (45.7 m), the skimming barrier is capable of encountering 665.5 barrels (106 m^3) of oil per hour when towed through a 0.04-inch- (1-mm) thick slick at a speed of 1.25 knots. The maximum recovery rate of the skimmer is estimated to be approximately 600 barrels (95.4 m^3) per hour (Halliburton, 1985). Currently, there are two Halliburton Open Ocean Skimming Barrier systems in Alaska. These systems are air transportable and can be relocated to other areas in Alaska.

(3) Skimming Vessels: Several skimming vessels are currently located in Alaska. These include the ACS's ARCAT Skimmer; CIRO's Lockheed 3100; and Alyeska's MARCO Class 1, Class V, and Class VII Skimmers.

ARCAT Skimmer: The ARCAT Skimmer is a 65-foot- (19.8-m) long, ice-strengthened, catamaran recovery vessel designed for recovery operations in the Beaufort Sea. The vessel uses a zero-relative-velocity rope-mop skimming system located between the two hulls and is currently equipped with four 18-inch (30.5-cm) rope mops. The rope-mop system was designed by Centrifugal Systems, Incorporated, and has an estimated maximum recovery rate of 180 barrels (28.7 m) per hour (Industry Task Group, 1984).

The ARCAT Skimmer is also outfitted with a plunging water-jet boom system for use under broken-ice conditions. The water-jet system consists of two horizontal booms mounted in a V-shaped configuration from the bow of the ARCAT. High-pressured water is emitted vertically from nozzles mounted on the booms, which creates an efficient funnel for directing oil into the skimming system as the vessel moves forward. The system gives an effective swath width of 35 feet.

Additionally, a weir skimmer can be deployed between the two hulls of the catamaran; and the vessel also is equipped with two fire monitors capable of producing a 4-inch (10.2-cm) stream of water at a pressure of 90 pounds per square inch (6.1 atm) for use in flushing oil from ice surfaces and herding oil. Two dispersant-spray booms can be attached to the bow of the vessel to provide a 50-foot (15.2-m) dispersant swath. The vessel is designed for operation during broken ice--its transit speed ranges from 0.5 to 1 knot for 6 to 7 oktas of decaying ice to 5 to 7 knots in open water and 1 to 2 oktas of ice (Industry Task Group, 1984).

Expected encounter rates at 3 knots for a slick that is 0.04 inches (1 mm) thick would be 64 barrels (10.2 m^3) per hour with the standard swath width of 6 feet (1.8 m). A Goodyear heavy-duty boom can be attached to each hull of the vessel to increase the swath width. With a Goodyear boom attached, a transit speed of 1.5 knots, and the swath width increased to 50 feet (15.2 m), the expected encounter rate would increase to 267 barrels (42.4 m^3) per hour.

The ARCAT is equipped with two heated, 90-barrel (14.3-m) storage tanks, which can be offloaded in 30 minutes. For easier pumping, the tanks are heated to reduce oil viscosity. For a major spill, the ARCAT would probably be operated in tandem with an independent storage barge.

To date, the ARCAT has not been used for actual spill-recovery operations, but it has demonstrated maneuverability and operation under open-water and broken-ice conditions during the State of Alaska's Tier II program and during various schools and demonstrations. Rope mops similar to those on the ARCAT have been evaluated at OHMSETT.

CIRO's Lockheed 3100 Skimming Vessel: This 27-foot (8.2-m) catamaran uses an oleophilic-drum system; it can skim at speeds up to 2 knots and has an open-water transit speed of 6 knots; and it is air transportable by C-130 aircraft. The manufacturer rates the skimmer's recovery at approximately 70 barrels (11.1 m^3) per hour for most oil viscosities with oil thicknesses at 0.5 inches (12.7 mm) at the recovery drum. Much higher recovery rates are possible if the skimmer is located in an area of highly concentrated oil or used in a V-boom configuration. The skimmer, which has a limited storage capacity of 9.5 barrels (1.5 m^3), was designed for operating under open-water conditions in conjunction with a towable storage bladder, or in tandem with another storage vessel.

The swath width of the vessel is 7 feet, 7 inches (2.3 m). The vessel-encounter rate of 40 barrels (6.4 m) per hour when it is operating in a 0.04-inch- (1-mm) thick slick at a speed of 1.5 knots can be increased with the use of a V-boom configuration from the bow of the vessel (CIRO Operations Manual, 1978).

MARCO Skimming Vessels: Alyeska Pipeline has three MARCO skimming vessels at their port facilities in Valdez: a Class I, Class V, and Class VII. All three skimmers use a porous, oleophilic foam-belt system to recover oil. An induction pump located behind the belt induces water flow through the belt. Some wave action can increase the recovery capacity by driving the oil to the belt and forcing the water through the belt.

The manufacturer states that the Class I system has a maximum recovery rate of 100 barrels (15.9 m^3) per hour. Such encounter rates with this system are, however, unlikely in the open ocean. In 1975, ARTEC, Incorporated, tank tested the system under broken-ice conditions for the USCG. The test demonstrated that the oleophilic-belt system would successfully recover oil in a broken-ice environment. Recovery rates ranged from 3.1 to 38.7 barrels (0.5 to 6.2 m^3) per hour. Tests were conducted in both freshwater ice and saltwater ice using No. 2 diesel and crude oils, which closely match Prudhoe Bay crude (Schulze et al., 1975). The width of the oleophilic belt on the Class I skimmer is 12 inches (30.5 cm), with a skimming speed up to 2 knots, and it can operate in sea conditions up to international sea state 2. The MARCO belt system has had extensive use on numerous spills since its introduction.

The Class V skimming vessel is a 36-foot (11-m) single-hull vessel using a 36-inch- (91.4-cm) wide oleophilic belt. The oleophilic belt is reported to have a recovery rate of up to 428 barrels (68 m^3) per hour. Experience has shown, however, that open-ocean encounter rates rarely meet such saturation levels of the filter belt. The maximum transit speed of the vessel is 5 knots with a recovery speed of 2 knots; it has a 40-barrel (6.4-m^3) storage capacity that can be transferred in 10 minutes; and it is transportable by C-130 aircraft. Recovery from the vessel is reported to be effective up to an international sea state of 3 (Marco Pollution Control, 1985).

The MARCO Class V skimmer has been thoroughly tested at OHMSETT under calm and 4-foot (1.2-m) harbor-chop-wave conditions. The maximum recovery rate under calm-water conditions with a 0.12-inch (3-mm) slick was 78.6 barrels (12.5 m^3) per hour using a medium-viscosity oil with a tow speed of 2 knots. With a 4-foot (1.2-m) harbor chop and a 0.12-inch (3-mm) slick, the oil-recovery rate was as high as 52 barrels (8.27 m^3) per hour using a tow speed of 1.5 knots and medium-viscosity oil (Smith, 1981). The swath width of the vessel is 6 feet (1.8 m), and the oil-encounter rate of a 0.04-inch- (1-mm) thick slick at 1.5 knots is 32 barrels (5 m^3) per hour. The swath width can be increased by using a V-boom configuration on the bow of the vessel. A 50-foot (15.2-m) swath would give an encounter rate of 266 barrels (42.3 m^3) per hour.

The MARCO Class V system has been used on numerous large spills in recent years. Four Class V skimmers were used during the *Ixtoc* spill in 1979. The skimmers were deployed for shoreline protection, and recovery rates of up to 64 barrels (10.2 m^3) per hour were achieved (Steve Blackbourn, MARCO Pollution Control, 1985).

The MARCO Class VII skimming system is incorporated into a 48-foot (14.6-m) vessel that allows for more independent operation over the Class I and V systems. The 36-inch (9.14-m) oleophilic-belt system is rated at 428 barrels (68 m^3) per hour. Experience has shown, however, that encounter rates would most likely be less than the maximum recovery rate of the oleophilic belt. The manufacturer reports that the vessel can be used up to an international sea state of 4. Its transit speed is 7.5 knots and skimming speed is 2 knots. The onboard-storage capacity is 80 barrels (12.7 m^3). The pump capacity is 570 barrels (90.6 m^3) per hour. The encounter rates for the Class VII system are similar to those for the Class V system.

d. Skimmers Used in North Sea Operations: The Norwegians have done extensive offshore testing of recovery equipment with respect to North Sea operations. Most of the systems tested in the North Sea are not currently available for use in offshore Alaska. However, the recovery concept used in these skimming systems is similar to the advancing offshore-skimming systems in Alaska.

During the period 1980 to 1982, six offshore skimmers were tested offshore Norway (UNOCO Skimming System, Framnaes Mck. Vaerksted Skimming System, Romsdal Fiskevegnfabrikk Closed Trawl Skimming System, Fiskeredskap Open Trawl Skimming System, Romsdal Fiskevegnfabrikk and Fiskeredskap Oil Trawl with Weir Skimming System, and FRAMO Weir and Disc Skimming System) (Langfeldt et al., 1983). In one test, a weir/boom advancing skimmer system, manufactured by Framnaes Mck. Vaerksted, recovered 70 percent (88.0 barrels [14.0 m^3]) of encountered oil emulsion with a viscosity of 11,000 centistokes during 8.9-foot (2.7-m) seas with an average wave period of 8.5 seconds. Under wind-generated waves of 5.6 feet (1.7 m) with an average wave period of 4.8 seconds, the skimmer recovered 60 percent (113.0 barrels [18.0 m^3]) of encountered oil emulsion. During these tests, the oil was released into the collection path of the skimming system. Recovery capacity (water and oil) of the six different skimming systems ranged from 629 to 1,987 barrels (100 to 316 m^3) per hour. The percent of oil recovered ranged from 13 to 78 percent with five skimming systems recovering over 40 percent of the oil.

Another offshore-recovery system, the Norwegian Oil Trawl, was tested offshore in 3.4- to 6.6-foot (1.0-2.0-m) seas and 17-knot winds in 1984 by the Norwegian Offshore Clean Seas Association. The manufacturer reports that the system recovered 195 barrels (31 m^3) of a 267.4-barrel (42.5-m^3) spill (73%) and rates the system as operational in winds up to 20 knots with 11.5-foot (3.5-m) waves.

2. Recovery Operations:

a. Recovery Operations During Ice Conditions: Solid-ice recovery operations center on the removal of oil and oil-contaminated snow that can be scraped from the surface of thick ice sheets with earth-moving equipment such as dozers, graders, and loaders. For smaller spills and thinner ice, manual labor using shovels and other hand tools is effective. Oil recovery from the surface of solid ice can be expected to range on the order of 85 to 95 percent.

Mechanical recovery of oil spilled in moving pack ice or ice that cannot support men and equipment is difficult; however, in situ burning techniques, which are discussed in detail later in this report, may be used. Oil that is spilled under the ice and becomes trapped within the growing ice sheet is also difficult to recover using mechanical means. It may take several seasons for the oil to surface in melt pools or melt out of the pack ice.

As previously discussed, small, portable skimmers can be used for mechanical removal of oil from melt pools on top of solid ice. Suction and oleophilic rope-mop skimmers are ideally suited for such an operation. High recovery efficiencies may be possible because the melt pools provide containment of the oil. Under these conditions, total oil recovery for small spills may approach 85 to 95 percent, providing that sufficient logistical support is available so that cleanup can be accomplished before ice conditions deteriorate and make recovery operations unsafe. However, oil encapsulated in multiyear ice may take several years to surface, and recovery operations will be much more difficult.

Open-water and broken-ice recovery techniques may be used to recover oil from pack ice as it melts out. The effectiveness of such an operation may be questionable if the oil is scattered, weathered, and/or widespread over a large area.

During broken-ice conditions, mechanical recovery operations can be conducted in open-water areas among broken-ice fields, in leads, and in pools of oil that may accumulate along ice edges. Portable skimmers can be deployed from barges or tugs that are capable of maneuvering within the broken-ice fields (Industry Task Group, 1983). Large skimming systems and skimming vessels can be effectively used in the open-water areas and leads. In situ burning, however, is the primary response mechanism under these conditions. In a 1983 evaluation of industry's spill-response capabilities, S. L. Ross Environmental Research Limited estimated that for an 840,000-barrel (133,566-m^3) spill occurring over a 12-week period during broken-ice conditions, where ignition of the well did not occur, 8 percent (67,200 barrels [10,685 m^3]) of the total spilled volume could be recovered by mechanical means.

b. Recovery Operations During Open-Water Conditions: Under calm, open-water conditions, the use of small, portable skimmers within containment booms is very effective. Offshore skimming systems and vessel skimmers can effectively operate and recover oil in international sea states up to 3 and 4.

The 1983 S. L. Ross Environmental Research Limited study also examined the efficiency of mechanical oil skimmers and skimming systems. Nineteen recovery systems were reviewed for their potential recovery capabilities under assumed environmental conditions and oil types. Skimmers were divided into five major categories in accordance with their primary recovery principle. Three sets of curves (Fig. 9) were developed to summarize optimum oil-recovery rates for all skimmers. These curves demonstrate the potential usefulness of mechanical skimming systems in comparison to both natural and chemical dispersion.

Estimates for offshore recovery of oil in the Bering Sea during open-water conditions with existing prestaged cleanup equipment have ranged as high as 70 percent for a major blowout (Exxon, St. George Basin OSCP, March 1984). Historically, spill recovery during open-water conditions has been much less, with less than 10 percent of the oil spilled at sea having been collected at sea. One of the most successful offshore-recovery operations occurred in 1982 when the Greek tanker Katina collided with an anchor chain about 9.32 miles (15 km) north of the Hook of Holland in the North Sea. Approximately 10,250 barrels (1,630 m^3) of heavy fuel oil was spilled. Cleanup operations

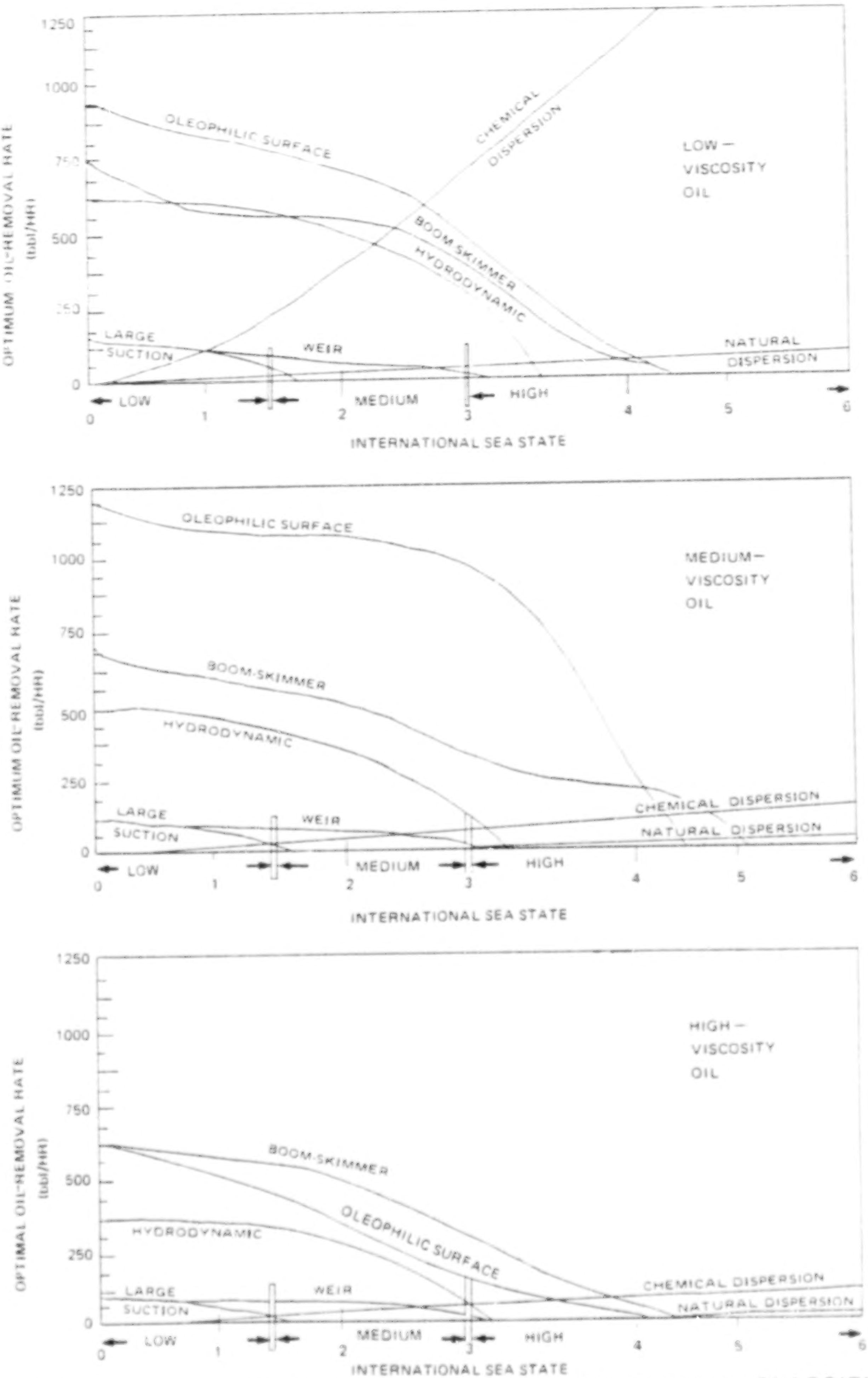

FIGURE 9. OPTIMUM OIL–RECOVERY RATE FOR GENERIC CLASSIFICATION OF SKIMMERS VERSUS NATURAL AND CHEMICAL DISPERSION

SOURCE: S.L. Ross Environmental Research limited, 1983

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were conducted over a period of 48 hours using three large oil-recovery vessels. These vessels were able to recover nearly 50 percent of the oil from the sea surface. Skimming operations were halted when the seas reached 6.5 feet (2.0 m) (Koops, 1985).

Other recovery operations have not been so successful. One such case is the Burmah Agate spill of 1979, off Galveston, Texas, which resulted from the collision of a freighter with this Liberian tanker. The tanker was carrying a blend of Nigerian crude (29.1° API and 39.3° API), and nearly 47 percent of the total cargo--397,790 barrels (63,252 m^3) was consumed by fire. Of the unburned oil, less than 11 percent was recovered by offshore skimming devices (MARCO Class V skimmers, 36-inch Goodyear Boom, and the USCG Skimming Barrier). It was reported that the recovery equipment did not function properly in short-crested seas over 3 feet (0.9 m). High currents and steep waves that formed from the interaction of Gulf waves, shallow water, and surface currents made recovery operations difficult (Kana et al., 1981).

3. Emerging Recovery Technology: Ongoing research efforts may yield new technologies for offshore recovery of oil in arctic and subarctic areas. Several studies have concentrated on the mechanical removal of oil from broken ice. S. L. Ross Environmental Research Ltd. has tank tested two new concepts (a perforated inclined plane and a perforated revolving drum) for use in brash and mulched ice (ESRF Report 018, January 1986).

Arctic Canada Ltd. is also tank testing a model bow-weir device for use in broken ice. This system is designed to be fitted to the bow of ice-reinforced ships or icebreakers servicing offshore oil rigs or platforms, and a spray boom is included in the design to help separate the oil from the ice. A series of 69 tests were carried out to evaluate the efficiency of this concept. A maximum overall recovery efficiency of 21 percent was achieved with the model operating in a 70-percent ice concentration and a slick thickness of 0.25 inches (6.4 mm). The spray boom was 5.6 times wider than the ship's beam (Abdelnour, 1985).

Another technology that may some day improve offshore recovery of oil from blowouts is subsea collection. The MMS recently funded a feasibility study and preliminary design of a subsea-collection system and recovery vessels. The proposed collection system uses a very large crude carrier as a recovery vessel and a "funnel-type" subsea-collection system. The results of this study indicate that this system would be effective for large spills, such as those that might result from a subsea blowout; however, costs for such a system would be very high.

D. In Situ Burning

In situ burning of oil is a relatively new concept for removal and disposal of oil from offshore spills. Industry has almost unanimously adopted this response measure as their primary technique for major oil spills that occur during broken-ice conditions and for oil trapped under and within the ice. In situ burning eliminates the need for recovery, storage, transportation, and disposal of a large percentage of the spilled oil.

Successful in situ burning depends on vaporizing oil and raising its temperature for oxygen to react in a combustion process. Ideally, this is a

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self-perpetuating reaction. Once initiated, the combustion reaction produces enough heat to continue vaporizing the oil. The water below the oil slick acts as a heat sink that constantly draws heat away from the oil slick. When the temperature of the oil drops to where it is no longer being vaporized, the combustion reaction ends. The temperature at which vaporization occurs and the combustion process begins varies from crude to crude. Most crudes, however, contain volatile light ends that enable combustion to begin below 50°C (122°F). As the oil weathers, the more volatile light ends are lost, concentrating the more stable heavy ends and raising the ignition temperature. If the oil is spread thin, extremely weathered, or emulsified, it may be difficult or impossible to conduct effective in situ burning operations. It has been shown, however, that moderately weathered Prudhoe Bay and Canadian crudes can be effectively burned (Smith, 1985; Industry Task Group, 1983).

For most fresh oils, once a slick is burning, it will continue to burn until the slick thins to 0.04 inches (1 mm) (Energetex, 1978; Arctec Canada, 1977). The MMS is currently funding research at the National Bureau of Standards to better understand the burning characteristics of oil on water as well as the composition of the burn residues and smoke and behavior of the resulting smoke plume.

1. Solid Ice: Oil that is spilled onto solid ice spreads because of gravity. The extent of spreading is influenced primarily by the ice and snow characteristics, temperature, and the viscosity and pour point of the spilled oil. Under most circumstances, most of the oil accumulates on the surface of the ice and is absorbed by any snow that may be present. Several burn tests have been conducted on oil that was spilled onto the surface of ice and snow. In general, these tests showed that the best burn efficiencies were obtained on fresh oil and in areas where the oil tends to concentrate. Air temperature does not appear to have a significant effect on burn efficiency, but wind can extinguish the flame. In some areas where the oil is too thin to support combustion, the oil and snow can be scraped into burn piles. If a fire can be maintained in the center of each pile, the snow will melt and the oil will separate and continue to feed the center fire. Oil spilled onto the surface of ice in a major spill can be burned in situ with an expected efficiency ranging from 70 to 90 percent by volume (Schulze, 1985; Industry Task Group, 1984).

Oil spilled under solid ice will normally rise to the bottom of the ice sheet and will usually be contained in a relatively small area, providing there are no strong currents under the ice. It has been estimated that the mean storage capacity of oil under ice is 195,000 barrels (31,000 m^3) per square kilometer (.39 $miles^2$) inside the barrier islands and on the order of 1.8 million barrels (286,200 m^3) per square kilometer under multiyear ice in the Beaufort Sea (Kovacs, 1977).

Oil spilled under newly forming ice in the fall quickly rises to the surface because of the high porosity of the ice. Oil spilled under ice during the winter when the ice sheet is growing will eventually become encapsulated within the ice. For first-year ice in the arctic, the oil will surface through brine channels and cracks in the ice during the spring. In either case, the oil is available at the surface during the spring and summer for in situ burning. Oil that becomes encapsulated in highly deformed ice, such as pressure ridges in multiyear ice, may not surface or melt out as easily in

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the spring as oil spilled in fast ice. Under these conditions, the brine channels are often blocked by refrozen freshwater. Early studies by Comfort et al. (1980) indicated that it may take two or more seasons for oil to surface from such ice features, but more recent studies concluded that crude oil spilled under most miltiyear ice would surface quickly (Comfort et al., 1983).

Oil spilled in Bering Sea ice will move with the ice until released by melting. Effective *in situ* burning may not be possible if the oil becomes widespread and is released at rates that will not support combustion. Oil may, however, concentrate in and around the ice in concentrations high enough for effective *in situ* burning.

Industry currently maintains a supply of air-deployable ignitors on Alaska's North Slope that are designed to be thrown from a helicopter into pools of concentrated oil and would be quite effective for spills that occur in a fast-ice area. However, if ice movement breaks up the oil-contaminated area and spreads the oil over a large area, the requirement for air-deployable ignitors and helicopters would be extensive--thousands of ignitors would be required to treat a major spill under such conditions. In the case of a winter spill, industry would have ample time to obtain additional ignitors before meltout would occur.

In 1974 to 1975, tests were conducted at Balaena Bay in the Canadian Beaufort Sea to determine the effectiveness of *in situ* burning of encapsulated oil that had migrated to the surface during the spring. These tests demonstrated that *in situ* burning can be quite effective for spills under fast- or stationary-ice conditions. Burn efficiencies were estimated to be as high as 70 to 80 percent (Pallister, 1978). Later tests demonstrated that even highly emulsified oil would surface through brine channels. It was much more difficult to ignite the emulsified oil, but burn efficiencies ranged from 14 to 63 percent for each individual test melt pool (Buist et al., 1983).

In moving pack ice, the oil may become widespread over a large area, presenting a logistics problem in locating and burning the numerous small pools of oil. In other instances, the slow oil meltout from multiyear ice may require repeated efforts to effectively burn the spilled oil.

Research is currently underway to develop ignition systems that are more logistically efficient. One system that appears to have potential is a helicopter-mounted laser-ignition system. A prototype laser-ignition system is expected to be tested at the OHMSETT facility in New Jersey in 1987 and in the field the following year. Industry is also sponsoring research into more efficient ignition systems, such as those used by the forest industry for their burning operations. If these systems become available and can be used to ignite weathered or emulsified oil, the efficiency of *in situ* burning of widespread and highly weathered oil in many areas may reach as high as 70 to 80 percent.

2. *Broken Ice*: The behavior of oil during broken-ice conditions depends on the physical properties of the oil, temperature, ice concentrations and movement, wind, waves, and currents. Because numerous combinations

of these factors are possible, the behavior of the oil in broken-ice conditions will vary greatly. Some tests have been performed and certain behavioral aspects are known: (1) where the horizontal spreading force of the oil is greater than the restraining force of the ice, the oil spreads with little influence from the ice, and the oil herds the ice along the surface of the water; (2) when the horizontal spreading force of the oil is not enough to move the ice, the ice restricts its spreading and offers some natural containment; and (3) wind tends to move oil at greater speeds and sometimes in a different direction than ice. Another factor to consider is the ability of oil to spread by moving through the gaps in a broken-ice field--it has been shown that most crude oils do not move readily through a densely packed ice field (Schulze, 1985). The oil tends to concentrate in or against tightly packed ice fields or against the windward side of ice floes. It is generally accepted that ice concentrations of 60 percent or better (5+ oktas) provide good natural containment of most crude oils. If the oil becomes weathered and the oil/ice mixture is subjected to continual grinding action by waves, the oil may be dispersed into progressively smaller pockets and spread over a wide area. The action of oil, waves, and ice may cause the formation of emulsions that are difficult to burn or to clean up mechanically. Such was the case with the *Kurdistan* spill in Cabot Strait in 1979.

In situ burning during broken-ice conditions may be accomplished by deploying ignitors from a helicopter into areas where the oil concentrates and where the slick is thick enough to ignite. Limited *in situ* burn tests independently conducted by the USCG, industry, and the OHMSETT facility indicate that this response measure can be very effective.

In March 1986, a series of field tests were conducted offshore Nova Scotia to validate the results of small-scale tank tests for oil behavior and burn efficiencies in pack-ice conditions. Three spills of one cubic meter each of Alberta crude were placed in pack-ice conditions of 4 to 6 tenths and 7 to 8 tenths, with small floes and medium floes, under freezing conditions, and with swells up to 13 feet (4 m). In one test, the ice conditions were described as very dynamic due to the swell propagation through the ice field.

The spreading of the oil was observed and the interaction of the oil and ice was closely monitored. The spills were allowed to interact with the ice for several hours until it was determined that spreading was essentially complete.

In two of the spills, *in situ* burning was used as a removal technique. Up to 80 percent of the oil was removed in one test and 77 percent in the other. The results of these tests are presented in Table 3. The researchers concluded that emulsification and dispersion did not seem to play as important a role in determing the fate of a spill in pack-ice conditions as in open water, and that *in situ* burning is an effective countermeasure for oil-spill response in dense, pack-ice conditions (Proceedings of the Ninth Arctic Marine Oil-Spill Program, June 1986).

As a general rule, fresh crude oil in higher concentrations of broken ice is easily ignited, and from 50 to 90 percent of the oil by volume can be removed by *in situ* burning in ice concentrations greater than 40 percent. Emulsions can also be successfully burned, but the efficiencies are drastically reduced. Emulsion burn efficiencies at OHMSETT have ranged from less than 10 percent

Table 3
Canadian Pack Ice Spills

Spill No.	Ice Conditions (Tenths)	Swell	Air Temp. °C	Wind Speed	Percent Evaporated	Volume Burned
1	4-6	Up to 13 Ft	-8	21	25-30%	0%
2	7-8	---	-14	18	5%	77%
3	4-6	Up to 2 Ft	-11	11	4%	50%

Source: Proceedings of the Ninth Arctic Marine Oil-Spill Program, June 1986.

for an 18-percent water/82-percent Prudhoe Bay crude to 35 percent for an 8-percent water/92-percent Prudhoe Bay crude (Smith, 1985). Preliminary results from OHMSETT tests in 1986 indicate that some crude/water emulsions can be more effectively burned than others. A 10-percent water/90-percent Hybernia crude emulsion was easily ignited in an ice concentration of 90 percent and burned with an efficiency of approximately 75 percent.

3. Open Water: In situ burning of unconfined oil in temperate waters has not historically been successful, partly because slick thicknesses in warm waters are too thin to support continued combustion. Burn efficiencies of large tanker spills have been somewhat more successful. In the Burmah Agate spill, 47 percent of the oil was consumed by fire in or near the vessel (Kana et al., 1981). Most oils, however, behave differently under cold-water conditions and will spread under the influence of gravity until a slick thickness of 0.08 to 0.2 inches (2-5 mm) is reached (Schulze, 1985; Smith, 1984). These slick thicknesses are burnable based on tests at OHMSETT. Over time, additional spreading of the slick will occur due to wind, waves, and current--winds will break up the slick into long, parallel windrows, and wave action may cause certain oil types to form unburnable emulsions.

Burn tests conducted by Buist and Twardus suggested that ignition and burning of uncontained batch-oil spills might be a feasible countermeasure and that combustion efficiencies up to 90 percent may be possible. They concluded that combustion efficiency is a function of spill volume and prompt ignition; however, additional investigation is needed to verify efficiencies (Buist et al., 1984). The MMS is currently participating in a study at the National Bureau of Standards to model and investigate the physics of uncontained in situ burning.

For continuous spills and slicks that are too thin to support combustion, containment and burning of the oil within fire-resistant booms will improve the expected efficiency. Several fire-resistant booms have recently been developed and tested for this purpose. These booms can be deployed downstream of a blowout or a continuous spill to concentrate the oil for effective burning. Burn efficiencies of 70 to 95 percent are typical of burn tests using fire-resistant booms. It has been estimated that a spill of 5,000 barrels (795 m^3) per day would require only 300 feet (91.4 m) of fire-resistant boom deployed downstream in a "U"-shaped configuration to adequately contain and burn the oil flowing from a gravel island. This is based on a burn rate of 0.07 gallon/minute/square foot (0.26 l/minute/m^2), and the area of the burn equal to one-third of the depth of the boom, with the boom width equal to three-tenths of the boom length (Spill Response in the Arctic, Part 3, 1984). Some of these booms are capable of withstanding at least 24 hours of continuous burn without destruction or failure. There are currently over 3,500 feet (1,067 m) of fire-resistant boom in Alaska.

Even though the efficiency figures of all the tests on in situ burning conducted to date are not conclusive, they do indicate that in situ burning of oil in the arctic may be far more effective than other recovery methods currently available for OCS spills in temperate waters. Efforts are currently underway by U.S. and Canadian Government agencies and private industry to assess the effectiveness of in situ burning for arctic and subarctic areas and to develop new products for more efficient burning.

E. Dispersants

Oil on a water surface is naturally broken up by the motion of waves. This process is called dispersion. Natural dispersion of oil in water tends to be effective at higher sea states (8-10' waves) and not so effective at lower sea states. To aid natural dispersion in lower sea states, chemical dispersants can be used to help the sea disperse the oil.

1. Chemical Dispersion: Chemical dispersants contain surfactants that decrease the interfacial tension between the oil and the water, thus reducing the cohesiveness of the slick. Aided by wind and waves, the oil is dispersed into the water column in the form of small droplets.

Chemical dispersion does not remove the oil from the environment. It breaks up the oil into small oil droplets and thus allows the oil to be mixed with the underlying water. Dispersed oil ultimately will be biodegraded, taken up by marine organisms, or be incorporated into the bottom sediments; or it will remain suspended in the water column.

Dispersants are usually thought of as a last line of defense in spill response, to be used only when containment and mechanical recovery of oil is not feasible and when a sensitive shoreline or a large group of seabirds or marine mammals is threatened.

Chemical dispersants come in three basic forms: water-based, solvent-based, and concentrates. The type of dispersant used in an operation depends on the particular type of oil being treated, local surface conditions, the amount of mixing energy available during application, and the availability of the dispersants. In general, water-based dispersants require more time and mixing energy to effect complete dispersion, while concentrates require the least amount of mixing energy. Solvent-based dispersants are primarily used for treating waxy or heavy oils. Concentrates are the primary type of dispersant used for aerial application.

2. Dispersant Applications: Dispersants can be applied by spraying from watercraft, fixed-wing aircraft, helicopters, or from portable backpack-spray units. The backpack-spray units normally are used for small spills and the other application systems for larger spills.

Backpack-spray units are primarily used for dispersing small harbor spills or spills on shorelines. As a preventative measure, a threatened shoreline can be treated with dispersant prior to the arrival of oil, but this measure may disperse the oil into the sediments, resulting in a more difficult cleanup operation. A small area of the shoreline should be tested before treating a larger area to determine if the dispersant is compatible with the oil and soil type. Although the use of dispersants as a preventative measure is not approved by the Regional Response Team (RRT) or the USCG as a valid response technique, this example is included to show how dispersants might be used in an emergency situation.

The effectiveness of a dispersant response is primarily controlled by three factors: the dispersability and condition of the oil itself, proper selection of dispersant type and application equipment, and the availability of adequate mixing energy once the dispersant has been properly applied.

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Choosing the correct type and size of spray nozzle for use in a dispersant application from a watercraft or aircraft is one critical factor in the outcome of the operation. The dispersant drop must be the correct size to effectively react with the oil. Equipment producing a dispersant droplet that is too large appears to result in oil herding, creating areas of open water in the slick. Droplets that are too small may not reach the slick due to wind; and if they do encounter the slick, they will not disperse the oil. Once an appropriate dispersant has been selected, the proper combination of pump pressure, nozzle size, application rate, and mixing energy is required for effective dispersion of oil.

3. Dispersant Effectiveness and Research--Cold Arctic Regions

a. General: The effectiveness of dispersants in arctic regions is still under debate. To date, there has been a lot of laboratory research conducted regarding the effectiveness of various dispersants on different oils and the relative toxicity of dispersants to marine life. These tests have shown that dispersants can effectively disperse most oils under ideal conditions. Research also has shown that different dispersants work better on different oil types under specific kinds of environmental conditions. There is no single dispersant that works best on all oils under all environmental conditions. Much of the research, however, has been done for dispersants in temperate waters--the effectiveness of dispersants in cold arctic regions is still under debate. Many of the field tests that have been carried out do not agree with the results of these laboratory studies.

The viscosity of an oil should be less than 2,000 centipoise for most dispersants to work effectively (International Tanker Owners Pollution Federation Limited, Technical Information Paper Number 3, 1982). Above this viscosity, the oil is too thick to be efficiently dispersed. This creates a time-related problem because the viscosity of oil increases as it weathers or forms emulsions.

b. Baffin Island Oil-Spill Project: Information cited in this report on the Baffin Island Oil-Spill (BIOS) project was taken from the Technical Proceedings of the 1980 to 1985 Arctic Marine Oil-Spill Program (AMOP) conferences.

One of the most important research projects to date dealing with chemical dispersants in the arctic was the BIOS project. This project was initiated in March 1980, off of Cape Hatt, Baffin Island, Northwest Territories, Canada, by the Canadian EPS, with joint funding from U.S. Federal and private sectors.

A primary objective of BIOS was to determine the biological effects of dispersed oil versus the effects of nondispersed oil in the arctic. Two spills were released into two similar bays. One spill consisted of aged crude oil and the other spill was a mixture of crude oil and Exxon's dispersant, Corexit 9527. The effects of both spills on the local subtidal benthic community were studied over a period of 4 years. Analysis of the results of the BIOS project led researchers to conclude that neither the crude oil spill nor the crude oil/dispersant spill had any acute environmental effects on the local benthic community during the short term (3 years). Oil-spill information on the long-term effects will be much more difficult to assess, but future work, if conducted, will provide additional information regarding dispersant use.

As part of the BIOS project, dispersants were also applied to oil-contaminated beach sediments. The researchers concluded that dispersant use as a shoreline-cleanup technique for beaches in arctic environments is not recommended due to high costs and logistic requirements in remote areas. Other major conclusions drawn from the BIOS project are that dispersants in sheltered nearshore environments are not a viable cleanup technique due to the lack of mixing energy. To be effective, sufficient mixing energy would have to be supplied artificially.

Actual field trials using dispersants have generated controversy over the effectiveness of modern application systems. Studies show that dispersants applied by aircraft form droplets of different sizes. The larger droplets, being heavier, strike the slick first and apparently herd the oil, forming areas of open water. The smaller droplets may hit these open-water areas, reducing dispersant effectiveness.

4. Dispersant Availability and Use in Alaska:

a. Availability: Many types and brands of dispersants are available. British Petroleum and Exxon Chemical Americas are the world's largest manufacturers of dispersants. Exxon states that Corexit 9527 could be produced at a maximum rate of 22,000 to 50,000 gallons per day (83-189 m^3 per day), if needed, from their manufacturing site in Houston, Texas (Spiltec, Alaska Oil Spill Chemical Application Manual, June 1986). Exxon's Corexit 9527 is the most abundant dispersant stockpiled in Alaska--the ACS has approximately 11,000 gallons (41.7 m^3) of this dispersant stored in Alaska.

Corexit 9527 is designed for use on salt water or brackish water with minimal mixing. This dispersant is not recommended for use in freshwater. The motion of the sea is usually adequate to effect dispersion of oil. Depending on the type of oil being treated, one part of Corexit 9527 will treat approximately 10 to 60 parts of oil under optimum conditions. Using a ratio of 1:30, the current Alaskan stockpile could potentially treat a 13,800-barrel (2,194-m^3) spill (1 barrel = 42 gallons).

Tests carried out by Esso Resources in November 1984 in a wave tank in Calgary, Canada, tested, among other things, the effectiveness of Exxon's Corexit 9527 in cold salt water on Alberta Sweet Mixed Blend crude oil (so-called Federated crude) from Esso's Strathcona Refinery (Brown et al., Eighth Annual AMOP Technical Seminar, June 1985). Water temperatures during the test averaged 28°F (-2°C). Dispersants were applied to 20 quarts (75 L) of oil by means of a spray boom suspended on guy wires 3.3 feet (1.0 m) above the surface of the wave basin. It was estimated that the dispersant drop size was on the order of less than 0.4 inches (1 mm) in diameter. These tests indicated that Corexit 9527 is effective in dispersing oil in arctic-like water salinities and temperatures. Dispersant effectiveness ranged from 3 to 33 percent. Effectiveness increased with increasing wave heights. For these tests, effectiveness was defined as the amount of oil entrained in the water column 24 hours after commencement of the test and 20 hours after wave agitation ceased. The tests were conducted with low-energy waves ranging in height from 3.9 inches (10 cm) to 7.9 inches (20 cm), with minimal mixing energy.

b. Permission to Use: In order to use dispersants in Alaska, permission must be obtained from the USCG On-Scene Coordinator (OSC), with the concurrence of EPA and State of Alaska representatives to the RRT. Historically, such permission has been difficult to obtain in a timely manner because of the controversial question about the possible benefits versus the potential adverse effects of a dispersant operation. Many have begun to realize that this question can only be answered through actual use of dispersants during spills of opportunity. As such, an effort is under way to develop guidelines for dispersant use. Such guidelines, if adopted by the OSC and RRT, would eliminate much of the difficulty in obtaining permission to use dispersants.

c. Dispersant-Application Guidelines: Presently, the Alaska RRT is in the process of formulating dispersant-application guidelines for Alaska. These guidelines are designed to establish areas and the conditions for which the USCG OSC can approve the use of dispersants without formal consultation with the EPA and the State of Alaska. To date, guidelines have been established for the Cook Inlet Region.

5. EPA Dispersant List: The EPA has devised a dispersant list called the National Contingency Plan (NCP) Product Schedule. The NCP Product Schedule is a list of dispersants that have been tested by the EPA. A dispersant's presence on the Product Schedule indicates only that toxicity and effectivness tests have been performed--it does not mean that EPA has endorsed a particular dispersant. Neither does the schedule give an estimation of a dispersant's effectiveness (40 CFR Part 300, National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule, November 1985).

6. General Viability and Evaluation of Dispersants:

a. Decision to Use: Dispersants appear to be a viable cleanup technique if applied on a case-by-case basis (University Energy Center and University of Rhode Island, 1981). The decision to use dispersants should be based on whether they will mitigate the environmental effects of a spill. For spills occurring in the open ocean that are being driven toward a marine community, the use of dispersants could reduce the environmental effects of the spill. Dispersant use in low-energy areas with poor circulation that will not provide rapid dilution is more questionable, and the decision to use dispersants in such areas will require more study.

b. Field Tests and Evaluations:

(1) Canadian EPS Report: The Canadian EPS recently released a report describing the results of approximately 50 dispersant field tests from around the world that took place during the period from 1976 to 1985 and included dispersant application from ships, helicopters, and airplanes (Fingas, 1985). In the report, Fingas states the oil type, viscosity, spill amount, dispersant type, dosage rate, and sea states and estimates the effectiveness of the dispersant treatment. Of the field tests deemed most

effective, the average effectiveness value is only 33 percent. In arriving at this effectiveness value, Fingas omitted tests where the dispersant was premixed with the oil. Overall, he concludes that these field tests showed that dispersants are not very effective in dispersing oil except when the dispersant is premixed with the oil. Premixture of a dispersant/oil mixture may be effective in field trials, but this is not a practical technique for actual spills.

Fingas goes on to state some observations on dispersants based on the above field tests. He notes that field tests performed in higher sea states were more effective and that tests conducted with higher application rates marginally improve performance. Other information in this article reaffirmed ideas already expressed in this section, including the fact that application techniques are critical to dispersant effectiveness, that correct techniques are difficult to implement, and that sea energy is crucial to dispersant effectiveness. According to the field tests studied by Fingas, international sea states less than 1 will result in dispersant effectiveness of 10 percent or less.

(2) Current Evaluation Projects and Studies: Several projects are currently under way to evaluate the feasibility of dispersant use in the arctic and subarctic.

o The ACS has recently published a chemical applications manual titled Alaska Oil Spill Chemical Application Manual and is sponsoring cold-water dispersant-effectiveness tests. The tests are scheduled to be conducted in a wave basin in Calgary during the latter part of 1987. Spiltec completed the chemical application manual for ACS in June 1986.

o Several other projects are under way in Canada. These include an evaluation of mixing dispersants within the hull of a leaking tanker using an inert gas, laboratory testing of new dispersants, and dispersant field trials in the Beaufort Sea. Work is also being conducted on the use of emulsion inhibitors to promote natural dispersion.

o The National Science Foundation is just beginning a dispersant study. The study is expected to examine the effectiveness and toxicity of available dispersants and the effectiveness of dispersant-application techniques; it will serve as a consensus opinion from leading authorities.

7. Summary: Some general points that agencies, industry, and researchers agree upon concerning dispersants are as follows:

a. To maximize effectiveness, dispersants must be applied to an oil slick as early as possible. Recent research shows that dispersants are effective only when they are exposed to fresh oil. Once an oil slick has weathered or has formed an emulsion with water, dispersant application will not effectively disperse oil. In general, a dispersant is less effective as the light hydrocarbon ends of an oil evaporate.

b. For dispersants to be effective, certain energy levels must be available to mix the chemical into the slick. The energy level needed for dispersant use depends on the type of chemical being used and the

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type and condition of the oil. Normally, the wave action produced by the vessel applying the dispersants or the wave action produced by agitation devices (e.g., breaker boards) towed by a ship will provide sufficient mixing energy. In the arctic, application of dispersants may require larger amounts of mixing energy because of the dampening effects of broken ice on waves.

c. Dispersants must be applied to the oil. They will have no effect on dispersing the oil if they are applied to the water. For this reason, spotter aircraft are recommended for any dispersant operation.

d. The effectiveness of dispersant use requires additional field use of dispersants in order to establish their effectiveness under realistic conditions, along with the standardization of laboratory evaluation techniques.

F. Shoreline Cleanup

The techniques used to clean up shorelines in Alaska are varied. The specific techniques used will depend upon the environmental conditions, the type of shoreline to be cleaned, logistical requirements, and the physical properties of the oil.

1. References--General: For a lessee preplanning a shoreline cleanup or for a regulatory agency trying to determine the adequacy of a lessee's shoreline-cleanup strategy, it is imperative to know what type of shoreline must be dealt with and the relative value and vulnerability of the resources that must be protected. Several documents have been published in recent years that categorize shoreline areas of Alaska's coast by breaking the shoreline down into soil type, vegetation, and major geographical features. Two such documents that deal with Alaska's North Slope from Barrow to Demarcation Bay and are useful for shoreline-cleanup activities are the Alaskan Beaufort Sea Oil-Spill-Response Considerations Manual, ABSORB Contingency Plan Supplement, Volume I (August 1982), and the Alaskan Beaufort Sea Coastal Region, Biological Resources Atlas, Alaska Clean Seas Contingency Planning Manual Supplement, Volume II (June 1983), both authored by ABSORB member companies. A third document, Atlas of the Beaufort Sea (October 1984), prepared by I. M. Lissauer, L. E. Hachmeister, and B. J. Morson for the USCG is a good reference document on oceanography, meteorology, ice, and climatology conditions from Barrow, Alaska, to Demarcation Bay, Alaska.

Similar documents for other areas in Alaska that can be of value in conducting a shoreline-cleanup activity are Oil Spill Sensitivity of Coastal Environments and Wildlife - Norton Sound and the Pribilof Islands, Alaska (National Oceanic and Atmospheric Administration/Outer Continental Shelf Environmental Assessment Program [NOAA/OCSEAP] Research Unit (RU) No. 59, August 1984); Sensitivity of Coastal Environments and Wildlife to Spilled Oil, Alaska - Shelikof Strait Region (RPI Inc., NOAA/OCSEAP RU No. 59, February 1981); Coastal Morphology, Sedimentation, and Oil Spill Vulnerability - Northern Gulf of Alaska (University of South Carolina, NOAA/OCSEAP RU No. 59, December 1977); Oil Spill Vulnerability, Coastal Morphology, and Sedimentation of Outer Kenai Peninsula and Montague Island (University of South Carolina, NOAA/OCSEAP RU No. 59, April 1980); Oil Spill Vulnerability, Coastal Morphology, and Sedimentation of Kotzebue Sound (RPI, NOAA/OCSEAP RU No. 59, 1979); Chukchi Sea Coastal Studies, Coastal Morphology, Environmental Sensitivity, and Persistance of Spilled Oil (Woodward and Clyde Consultants, NOAA/OCSEAP RU No. 644, Ongoing Study); Coastal Morphology, Sedimentation, and Oil Spill Vulnerability of the Beaufort Sea (RPI Inc., NOAA/OCSEAP RU No. 59, April 1980); Coastal Morphology, Sedimentation - Gulf Coast of Alaska (RPI, NOAA/OCSEAP RU No. 59, February 1981); and Coastal Morphology, Sedimentation, and Oil Spill Vulnerability of the Bristol Bay Coas (RPI, NOAA/OCSEAP RU No. 59, 1982).

2. Shoreline-Cleanup Techniques: Once oil has entered into a shoreline area and the type of shoreline has been categorized, the type of cleanup technique most likely to be of value can be determined. Several charts in the literature can be consulted regarding the most suitable type of cleanup technique to use on a specific shoreline. Two such charts are Table 4, Cleanup Methods and Shoreline Types, and Table 5, Shoreline-Cleanup Methods, both from Shell Western E&P, Inc.'s, Oil-Spill-Contingency Plan for OCS Lease Sale 87, Beaufort Sea, Alaska, March 1985.

The following paragraphs present some specific information on shoreline-cleanup techniques. Some useful documents giving more detail about the techniques discussed are the Gulf of Alaska Cleanup Organization (GOACO) Operations Manual (1982, prepared by Marine Consultants for GOACO) and the Alaska Clean Seas Contingency Planning Manual, Core Document, Volume I (prepared by Alaska Clean Seas member companies).

a. Direct Suction: If a beach, rocky area, or marsh has been contaminated with large volumes of oil, and the oil has pooled naturally in low spots or poorly drained areas, the use of direct suction can be a viable cleanup method; however, it must be stressed that the effectiveness of this technique on shorelines requires thick accumulations of oil. Direct suction can be accomplished with a pump, hoses, and a storage container. When using this technique, the vacuum nozzle should be held just above the oil's surface--if the nozzle is inserted into the oil, oil recovery decreases and water recovery greatly increases. For some operations, the use of a skimmer may be required if the oil has accumulated in onshore ponds. Basically, the pump is set up on a firm area and the hose is inserted into the pool. If an onshore pond is being cleaned, an appropriate skimmer is connected to the pump hose and the skimmer is put into the pond. The recovered oil can be stored in air berms, metal storage containers, natural depressions lined with an impervious material, or a truck used for storing liquids. Another option is to use a vacuum truck equipped with a pump to suck the oil and store it. These techniques also have merit when dealing with under-ice spills close to shore. Once a hole or slot in the ice has been made with an auger or a similar tool, the oil can be recovered as stated above. (This technique can also be used if a berm made of soil or snow can be constructed to pool the oil.)

Direct suction also can be applied to spills that have saturated porous soil types, such as sand and silt. To use this technique under such conditions, a trench is cut into the sediment by manual or mechanized means to act as a central collection point for the oil. Once the oil has pooled into this trench, it can be recovered with a pump hose or skimmer.

Table 4

Cleanup Methods and Shoreline Types

	HIGH-PRESSURE HOSES	STEAM CLEANING	SAND BLASTING	LOW-PRESSURE HOSES	MIXING	GRADER/SCRAPER	FRONT-END LOADER	BULLDOZER	DRAGLINE/ CLAMSHELL	SUMP/PUMP	MANUAL REMOVAL	MANUAL CROPPING	BURNING	BEACH-CLEANING MACHINES
Rock	+	+	+	✓	–	–	–	–	–	✓	✓	–	–	–
Man-Made	✓	✓	✓	✓	–	–	–	–	–	–	✓	–	–	–
Mud	x	x	x	x	x	x	+	x	x	+	✓	–	x	x
Sand	x	x	x	x	+	✓	+	+	+	✓	✓	–	x	✓
Pebble	x	x	x	x	+	+	+	+	+	+	✓	–	x	✓
Cobble	+	x	x	+	+	–	+	+	+	+	✓	–	x	+
Boulder	+	x	x	+	–	–	–	–	–	–	✓	–	x	–
Mixed Sediment	x	x	x	x	+	x	+	+	+	+	✓	–	x	✓
Marsh	x	x	x	✓	x	–	x	x	x	+	✓	✓	+	–

Source: Alaska Clean Seas Shoreline Protection School (prepared by Woodward-Clyde).

x NOT Recommended

– Not Applicable

✓ Recommended

+ Applicable and possibly useful

Table 5
Shoreline-Cleanup Methods

METHOD	DESCRIPTION	APPLICABILITY	EFFECT
HIGH-PRESSURE HOSES	- high-pressure stream of water washes oil from the substrate	- can be effective on rock, boulder, and man-made surfaces - oil flushed onto water surface for removal or channeled to beach collection site	- can damage flora & fauna - can flush oil into sediments - if beach is backed by unconsolidated cliffs, hosing of cliff can cause slumps, falls, or slope failure
STEAM OR HOT-WATER CLEANING	- steam or hot-water washes oil from the substrate	- very effective on rock, boulder, and man-made surfaces - oil flushed onto water surface for collection or channeled to beach collection site - expensive method	- can be very harmful to flora & fauna - can flush oil into sediments
SANDBLASTING	- high velocity sand removes oil from the substrate	- effective but slow method for rock, boulder, and man-made surfaces - can remove oil stains - expensive method	- can be very harmful to flora & fauna - scatters oil and sand - can cause deeper penetration of oil into sediments
LOW-PRESSURE HOSES	- low-pressure stream of water washes oil from the substrate	- effective but slow method for rock, boulder, and man-made surfaces - oil flushed onto water surface for collection or channeled to beach collection site	- biologically preferable to high-pressure hoses, steam cleaning, or sandblasting - can flush oil into sediments
MIXING	A-mechanical equipment such as rakes, discs or harrows used to break up oil cover and mix surface sediments	- accelerates natural cleaning - useful for light grade oils or to break up "asphalt pavements" - increases surface area of exposed oil and increases dispersal and degradation rates	- does not remove oil - can cause burial of the oil
MIXING (Cont.)	B-mechanical equipment used to push oil/sediment down beach into the water	- accelerates natural cleaning - wave action disperses and degrades oil - sediment is returned to the beach - applicable for "asphalt pavements" or coarse-sediment beaches	- does not remove oil - should not be used if storm waves are expected before sediment is returned to the beach; could result in waves overtopping the beach and/or causing backshore erosion
Removal			
GRADERS, SCRAPERS	- remove thin layer of oiled sediments - graders form windrows for scraper or front-end loader to remove - scraper removes oil/sediment layer directly	- effective on sand or pebble beaches with low oil penetration depths (less than 3 cm) - scraper can remove up to 25 cm layer of oil/sediment - some spillage which can be removed manually	- removes sediment from the beach, amount of sediment removed usually not sufficient to affect beach stability
FRONT-END LOADERS	- loader removes material directly from beach to collection sites	- used on beaches with poor traction or for high oil penetration depths (25 cm or more) - high spillage - usually large amounts of uncontaminated sediment are removed - rubber-tired vehicles are preferred to tracked vehicles	- can result in excessive sediment removal that could cause beach or backshore erosion - grinds oil into the beach
BULLDOZERS	- push material into collection sites for removal	- can remove oil/sediment where penetration is 25 cm or greater - not recommended unless other equipment unavailable or traction is too low for other equipment	- can result in excessive sediment removal that could cause beach or backshore erosion - large spillage and grinds oil into sediments
DRAGLINE, CLAMSHELL	- sediment collected in bucket dragged towards equipment, or by crane-operated bucket	- useful where beach access or trafficability is poor	- can result in excessive sediment removal that could cause beach or backshore erosion
SUMP COLLECTION AND PUMP REMOVAL	- sump excavated and used to collect oil which is then removed by pump or vacuum system	- useful for large spills with oil washed onshore over a period of days	- does not remove all the oil from the beach
MANUAL	A-oil scraped from the substrate	A/B useful for areas inaccessible to equipment or small spills	A-selective oil removal, not all oil is removed
	B-oil collected with buckets, shovels, rakes, forks, etc. (with or without sorbents)	A/B/C labour intensive methods; slow rate of oil removal	
	C-cutting of oiled vegetation	C-oil/vegetation collected in containers for removal	C-labour intensive method; pedestrian traffic can disturb marsh vegetation and can cause oil/sediment mixing
In Situ Cleaning			
BURNING	- oil ignited, usually with ignition agents - continued burning may require wicking agents	- seldom completely successful - useful for oil on surface of ice - can be used in marshes with appropriate biological advice - oil residues remain	- causes heavy air pollution - can increase the penetration of oil into the sediments - can damage root systems of marsh vegetation
BEACH CLEANING MACHINES	- cleaner picks tar lumps from the beach	- useful on beaches with tar balls	- little sediment removal

Source: Alaska Clean Seas Shoreline Protection School (prepared by Woodward-Clyde)

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Direct-suction cleanup techniques by vacuum truck were used off Buzzards Bay, Massachusetts, on January 28, 1977, when the Bouchard No. 65 barge ran aground (Schrier, 1979 Oil Spill Conference). The barge was carrying No. 2 fuel oil and spilled about 84,000 gallons (318 m^3) of the oil into the bay. The spill occurred during winter when Buzzards Bay was almost completely frozen. The shoreline was ice-fast, and the bay had ice-pressure ridges and numerous leads in it. Most of the oil ended up trapped in the leads between the ice. As part of the overall response, the USCG deployed large vacuum trucks, smaller skid-mounted units (both on land), and skid-mounted units from tugs and barges. Total recovery from all methods was approximately 23,500 gallons (89 m^3). Vacuum-truck-suction methods recovered 17,500 gallons (66.25 m^3), 74 percent of the total amount recovered. According to the USCG, vacuum skimming was the most efficient and probably the most cost-effective cleanup technique during the initial cleanup phase of the operation. Success of vacuum suctioning was attributed to the mobility of the suction hose in the leads, the ability of the trucks to reach the spill site, and the small number of people needed to carry out this technique.

b. Rope Mops: Rope mops, discussed when dealing with offshore recovery, also have applications for shoreline cleanup. Rope mops would find application for oil that collects on the shoreline in natural pools or in marshes. When using the flushing technique to clean up a shoreline, the oil trapped in a trench or a boom located close to the shoreline can be recovered with a rope mop.

c. Manual Removal: Where oil contamination is low or sporadic, or when penetration of the oil into the sediment is low, manual removal of the oil is preferred. Manual removal usually is used to some extent on any shoreline cleanup, in combination with other techniques or alone. Due to logistical constraints or to access constraints placed on heavy equipment in some areas, manual recovery may be the only cleanup technique possible for some shoreline spills.

This type of response is very time-consuming, costly, and labor-intensive; but, as stated above, it might be the only way to deal with a spill. Manual removal is a very selective method of removing contaminated sediment and vegetation, making it an extremely effective response technique. The effectiveness of a manual response is directly related to the amount of time, labor, and money the operator wants to devote to the problem. The more money and time invested in a manual cleanup operation, the greater the amount of oil that may be recovered.

Manual recovery involves the use of hand tools--such as rakes, shovels, buckets, pickaxes, brush cutters, scythes, and power brush-cutting tools--to remove contaminated sediment and vegetation. Oil-contaminated sediment or vegetation is collected and put into heavy-duty plastic or burlap bags for disposal. Bags may be removed manually, by vehicle, by boat or barges, or airlifted by helicopters to the disposal site.

Other manual-cleanup methods include combinations of techniques already discussed in this section. A technique tried by Standard Alaska Production Company (formerly Sohio Alaska Petroleum Company) was applied to an oil-affected wet-tundra area on the arctic coastal plain in 1981 (Pope et al., 1982). Basically, the method involved direct suction of oil from standing water and oil removal by sorbents in areas where direct suction could not be used. Next, crews went into the affected area and used handclippers and weed-cutting machines to trim the contaminated vegetation. The area was then raked to collect the contaminated vegetation that had been clipped for disposal and to aerate the root mats of the vegetation. Three weeks after the restoration, the area was observed to contain new plant growth. This type of technique seems to have potential for use in arctic wet-tundra locations, but it requires extensive labor.

d. Using Sorbent Pads, Booms, or Rolls and/or Burning: Sorbent pads, booms, or rolls are often used as part of a manual response, or they can be used in conjunction with other techniques. Small, isolated pools of oil on the sediments or on nearshore waters can be removed by using sorbents. Once the sorbent materials have become soaked with oil, they can be removed by the methods described above, or they can be burned. Burning can also be used to dispose of oiled vegetation or oil-contaminated logs and debris. Burning sorbents or vegetation is a very effective way of dealing with the disposal problem.

One problem to be overcome in any type of burning, whether it be burning of sorbents or in situ burning of oil pools, is the need to obtain a burning permit from the appropriate agencies prior to initiating the burn. For burns on State of Alaska waters or on land, the ADEC must issue a permit. Burns on inland waters above mean high tides or on non-navigable waters require an additional verbal authorization from the EPA. If the burn is to take place on coastal waters, the USCG must also issue a verbal authorization for the burn; burns on Federal offshore waters will require the spiller to obtain MMS approval. As this discussion shows, burning may require approval from one agency or a combination of agencies, depending on the burn's location.

e. Heavy Equipment: For certain areas during specific times of the year, heavy equipment can be used as an effective cleanup technique. Its use would require either the availability of roads or a means of air-lifting or barging the equipment to the contaminated area. Only certain soil types, such as sand or rocks, could withstand heavy equipment. Marshes or tundra shorelines may be able to handle the weight of the equipment during the winter when the soil is frozen--they could not withstand its weight during the summer months or during breakup.

Graders, scrapers, loaders, bulldozers, and backhoes are equipment that may be used in cleaning up shoreline areas. This equipment can be used in areas where the soil-bearing capacity is adequate and habitats are not harmed by removal of soils.

f. In Situ Burning: Another technique that has merit is in situ burning of oil or oil-contaminated shorelines. All that may be needed is a fire source, such as an ignitor or a portable backpack fire unit, and a means for disposing of any large pieces of burnt residue. This technique is a low-cost, effective technique for sufficiently removing oil-contaminated tundra material or free oil that has pooled in low spots in the landscape. Out of all the techniques, this one probably requires the least amount of manpower.

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g. Flushing or Washing:

(1) Low Pressure: For cleaning light oils, such as fuel oil, from lightly contaminated mud, boulders, tundra, or vegetation, low-pressure flushing or washing can be a viable cleanup technique. In performing this operation, water is pumped from the ocean and is flushed over the lightly contaminated sediment to remove the oil. The removed oil is trapped downstream in a manmade trench or in a boomed-off area of the ocean close to shore. Once the oil is trapped, it can be removed by direct suction, skimming, burning, or sorbent pads. This technique has several drawbacks:

- A nearby water source must be available, making this technique applicable only to shoreline areas.

- It is easier to carry out if the trench or boom can be located downslope from where the flushing operations are being conducted.

- In extreme cold, the water used for flushing may freeze on the sediment, making it impossible to continue operations.

- The flushing or washing operations may damage the sediment by erosion or by driving the oil farther into the sediment.

- It is extremely labor intensive.

(2) High Pressure: High-pressure flushing is basically the same technique as low-pressure flushing. The major difference is that higher water pressures are used for high-pressure flushing. Typical specifications for high-pressure flushing are a 10-gallon-(0.04-m^3) per-minute flow rate at 4,000 pounds per square inch (272 atm). The penetration of oil deeper into the sediment with high-pressure flushing is an even greater danger than for low-pressure flushing.

h. Steam Cleaning and Sandblasting: Steam cleaning and sandblasting are techniques that can be used to remove oil from rocks, boulders, and manmade structures. These techniques use high-pressure jets of steam or sand to physically remove oil from the contaminated surface. Care must be taken in using these techniques because the high-pressure streams can severely erode the sediment or damage any uncontaminated flora or fauna in the area.

i. Natural Dispersion: Another option in dealing with shoreline cleanup that could prove very effective in certain environments is natural dispersion. For contaminated shorelines close to high-energy ocean environments--such as sand, gravel, or cobble beaches--natural dispersion of the oil into the ocean could be very effective. Natural dispersion may be the only possible alternative when logistics or weather problems preclude a response effort.

3. Logistics--A Remote-Area Concern: Logistics are an important concern when dealing with remote arctic areas. Aircraft landing strips may be hundreds of miles away from the shoreline; roads may be nonexistent or

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totally impassable during summer months or breakup; and portable shelters, heaters, and entire camps may have to be brought onsite for long-term operations. All of these factors, coupled with disposal of oiled debris, complicate shoreline cleanup, making it one of the most difficult and expensive cleanup operations.

4. Research: Limited research is currently being conducted to develop new technologies for shoreline cleanup. The ACS is sponsoring research to develop a thin, lightweight, oleophilic mesh that can be applied to a shoreline to protect it from oil emulsion; then, on a receding tide, the mesh/oil can be removed for disposal. Other studies are concentrating on evaluating the long-term effects of oil-contaminated shorelines.

G. Wildlife Protection and Rehabilitation

As previously discussed, once oil is spilled on water, wind and currents act to move the spill from one area to another. If the oil cannot be contained or it cannot be removed by in situ burning at the spill location, the oil slick may drift to shorelines or other areas of important biological significance. Oil may be deposited on beaches, in tidal flats, along rocky headlands, and in marshes. Birds, marine mammals, and other wildlife may come into contact with the slick.

The primary purpose of oil-spill response is to reduce the potential adverse effects of spilled oil on the marine environment. The major concern is protection of wildlife, special biological resources, and habitat from the toxic effects of oil once it has been spilled. Most response efforts are directed toward immediate containment and recovery of the oil, or in situ burning of the oil as near to the spill source as possible. These methods remove the oil from the water and reduce the effects of an oil spill on marine resources that are most at risk.

1. Protection Measures: Protection measures can be categorized into three primary areas: (1) booming, to prevent the oil from entering a sensitive area; (2) dispersion, to prevent the oil from contacting and adhering to sensitive shorelines and surface wildlife; and (3) scare techniques, which move the wildlife from the area that may become contaminated with oil.

a. Exclusion: Exclusion booming involves the placement of booms to prevent oil from entering inlets, lagoons, channels, estuaries, rivers, and streams. Booms can be placed along shorelines to divert oil from a sensitive area to another area that is more suitable for recovery. The effectiveness of these techniques are only as good as the effectiveness of spill-containment booms under various wind, wave, and current conditions. The ability of a boom to contain, herd, or direct oil is discussed in the containment section of this section of the report.

b. Dispersion: Dispersants can also be used on spills that may move into an environmentally sensitive area. Dispersants do not remove the oil; they chemically allow the oil to mix into the water column, where it becomes dispersed and diluted. Properly dispersed oil is removed from the surface of the water and the tendency of the oil to adhere to wildlife is reduced. The effectiveness of dispersants is discussed in the dispersants section of this section of the report.

c. Scare Techniques: To date, scare techniques have been limited primarily to birds, although killer-whale sounds and certain boat noises have been used to displace some whales. Helicopters can be used to scare away some species of seabirds. Loud noise also can be used to keep birds from entering an area by using devices such as the propane-fired cannons. The ACS currently maintains 16 cannons on the North Slope and 20 in Dutch Harbor. The CIRO maintains 15 cannons in Kenai. Other methods, which either lure wildlife to another area or repel wildlife from a contaminated area, are unproven.

2. Rehabilitation: Rehabilitation of oil-contaminated wildlife may be necessary to protect species that are endangered or of high aesthetic value. Historically, oiled birds--except those that have been heavily oiled--previously have been successfully rehabilitated (most heavily oiled birds do not survive). Successful programs are very labor-intensive and have relied mostly on volunteer labor. A manual entitled Rehabilitating Oiled Sea Birds, developed by and available through the American Petroleum Institute (1985), serves as a guide for the rehabilitation of birds.

The ACS maintains a bird-rehabilitation kit as part of their response equipment. The kit contains materials to initiate a bird-rehabilitation program for 500 birds. Additional materials are commercially available in Alaska and can be flown to the area of operations should a large-scale-rehabilitation program become necessary.

Some studies have been done regarding the effects of oil on marine animals. These studies indicate that a few mammal species, such as seals and walruses, may rid themselves of oil by washing. Animals that groom themselves may ingest oil, which can result in mortality of the animal. Rehabilitation efforts may also stress certain animals, causing increased mortality and behavioral changes.

A rehabilitation program requires extensive manpower to locate, capture, treat, and care for oiled wildlife. It is difficult to estimate a success ratio, because success will be dependent upon the number of animals involved, the extent of oiling, the physiological condition of the animals, and the experience of the people undertaking the rehabilitation program.

3. Research: The State of Alaska has identified wildlife protection as a major area of concern needing additional research work. Industry is currently evaluating possible wildlife-protection-research options and is expected to fund such research in the near future.

H. Disposal

An important consideration during oil-spill-contingency planning is the storage and disposal of recovered fluids. The remoteness of potential spill sites, the presence of ice and permafrost, the lack of an approved State (Alaska) disposal site, and the potential (even though very slight) for a high-volume spill all play an important role in this decision process. This section identifies the methods industry has suggested for storage and disposal of oil and oily debris in Alaska.

1. Storage: Recovered oil must be temporarily stored until it can be disposed of properly. For small spills, collapsible storage containers, normally stored as part of the onsite-response equipment, are ideal. Limited storage is usually available on workboats, drilling units, in oil-water separator units associated with skimming systems, and on-board the skimming vessels themselves. Another useful storage device is the Dracone Barge, a flexible bladder-type tank that can be towed behind recovery vessels and used for temporary storage.

The ACS current temporary storage capacity is approximately 3,000 barrels (477 m^3). This includes flexible storage tanks, Dracone Barges, and oil-water separator units. Additional storage can be obtained using barges and tankers, which can be brought to a spill area.

2. In Situ Burning: In situ burning, both offshore and as a shoreline-cleanup technique, has been discussed previously in Section III. These techniques reduce the volume of spilled oil and debris that necessitates storage and disposal.

3. Incinerators: The use of incinerators for the disposal of oily debris is based upon experience with industrial-type debris incinerators previously used to burn brush alongside highways. Modifications have been made to these incinerators to deal with the problems of portability. Because of the remoteness of operations in the arctic, air-transportable incinerators have been developed. Design modifications have resulted in decreased weight and size, facilitating easier transport and setup procedures. Incinerators can now be transported to the spill site in just a few trips by medium-lift helicopters. Earlier incinerator models took up to 14 lifts by helicopter.

An important consideration when using these incinerators is the protection of underlying and surrounding permafrost. Unique methods have been developed to cool the outside of the incinerator to near ambient levels, thus ensuring minimal damage to the permafrost. This is also very important if the incinerator is to be set up on ice. Testing has proved the usefulness of several portable incinerators with minimal effect on the surrounding environment (ice, permafrost, air quality).

Burn rates of up to 1 ton per hour for oiled debris have been obtained by these portable-incinerator designs in various test situations. Disadvantages of the incinerators include the need for a helicopter or flatbed truck equipped with a hydraulic boom for transport and assembly. The use of a helicopter to aid the assembly can be a problem in the arctic because the "downwash" from the rotor can cause blowing snow and extremely cold wind-chill conditions. Initial startup is another problem with incinerators in extreme cold weather. Once started and operating, however, few problems should be experienced.

A Trecan incinerator is available at the ACS warehouse in Anchorage. This particular incinerator is not as portable as some designs but is capable of burning 1 ton of oily debris per hour. The ACS warehouse also has one air-portable incinerator for the disposal of oily debris. In the event of a spill, one or both of these incinerators would be transported to Prudhoe Bay for further mobilization.

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In addition, the Canadian Government has developed an incinerator that also moves oil through the water by ultrasonic herding. Preliminary investigations indicate that this device can burn oils not normally burnable with in situ techniques. The ultrasonic burner is air deployable and has burned heavy, tight emulsions and highly weathered oils.

4. Burners: Incinerators are not very effective when dealing with fluids, especially water emulsions. One method that can be used for the disposal of debris and burn residue recovered fluids is a portable oil burner. The distinction between flare burners and portable oil burners is discussed below.

Flare burners are very useful for burning off large quantities of recovered oil, but they are generally very heavy and require large air compressors for operation. They are not easily transportable, requiring several lifts by helicopter after disassembly or transporting by C-130 aircraft to be considered portable, which is a major drawback for an arctic disposal technique. They would serve as a very useful method of burning off recovered oil that has been transported to a shore base or centralized location.

An air-portable oil burner is capable of burning recovered fluids ranging from light fuel oil to heavy, weathered, residual oil and emulsions. The ability to deal with emulsions with up to 60-percent water is a definite advantage by reducing the amount of handling and equipment necessary to dispose of the recovered fluid. Separation prior to burning would enhance the efficiency of the portable burner. A simple gravity separator would be sufficient to bring the dilute emulsion (greater than 60% water) within the limits of the oil burner. Other advantages of these burners are portability (which is very important for arctic spills) and the ability to deal with suspended solids in recovered fluids. Some burners could be mounted on a barge or floating platform for incineration of recovered oil offshore.

Considerations when using these portable oil burners include the necessity of placing the equipment on a protective pad when the system is set up on permafrost or ice. Extreme heat of radiation from the burning could unacceptably affect the permafrost or ice. Further considerations involve logistical support, modification of transport vessels, and handling equipment for the debris and burn residue.

A Seaward International flare burner is stored at the ACS warehouse in Anchorage and is available for use in disposing of recovered fluids. Burning systems that are readily available can dispose of from 5,000 to 6,000 barrels (795-954 m^3) of oil or emulsion per day, and they can be mounted on barges and used offshore.

5. Dispersion: Dispersion, either natural or chemically induced, can be considered a disposal method. The effectiveness and fate of dispersed oil is discussed elsewhere in this report.

6. Other Disposal Methods: Other disposal methods include reclamation, burial, and injection. For the most part, burial and reclamation are not feasible for arctic spills.

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Reclamation is the process of sending recovered fluids to a refinery/treating facility for the extraction of useful products. The recovered fluids may also be treated to pipeline specifications and injected into a pipeline for transport to refining facilities. The cost of reclamation in the arctic probably would make such an operation prohibitive unless large volumes of "treatable" fluids were recovered.

Burial is considered practical only for oil-contaminated debris and beach sediment. The presence of permafrost and the lack of approved burial sites make this option a site-specific consideration. Hazardous wastes have been transported out of Alaska for disposal at approved disposal sites in the lower 48 states.

Injection is feasible if a disposal well is available for use and if there is sufficient storage to make up the difference between recovery rates and injection rates.

7. Research: Industry and Government have recognized a definite lack of information about the disposal of oil and oily debris. As part of the State of Alaska Tier II research program, oil-field-waste disposal is being studied. The intent of this study is to develop recommended procedures for the disposal of recovered oil and oily debris originating from spills. Additionally, an ACS-administered study will analyze recycling/reuse, underground injection, incineration, and disposal at an authorized land site. The outcome should result in criteria for selecting the appropriate disposal option and answer many of industry and Government concerns.

IV. SUMMARY

The responsibility to protect the environment from oil pollution has been established by the OCS Lands Act. The MMS has promulgated a series of regulations, OCS Orders, and guidelines to implement the requirements of the Act. These requirements set standards for safety, pollution prevention, and spill-response preparedness.

Proposed OCS activities undergo a thorough review for adequacy by the MMS, other Federal and State agencies, and the public. This includes a review of the individual oil-spill-contingency plans that are developed by lessees for exploratory and development programs.

Each company is responsible for conducting cleanup operations for spills that might result from their activities. Cleanup operations are monitored by the USCG and the MMS. The USCG has the authority and responsibility to take action to ensure that appropriate spill-response measures are taken.

Spill-response operations usually are organized for two levels of activity: minor spills and major spills. Onsite-response equipment and personnel are designed around small operational spills, such those that might occur during a fuel-transfer operation of less than 1,000 barrels. The onsite-response team also would provide the initial response effort if there were a major spill. A second level of response effort is designed to provide additional equipment and personnel for major spills, such as those that might occur from a blowout or other catastrophic event. Industry has developed several oil-spill-response cooperatives to provide major pieces of spill-response equipment that would support activities for a large spill.

The main objective in any offshore-spill-response effort is to minimize or prevent oil from contaminating shorelines or areas of biological or cultural importance. This can be accomplished by preventing the movement of an oil slick beyond the spill site and by recovering or removing the oil from the water, either by mechanical means or burning methods. Chemical agents, primarily dispersants, are an alternative that may accelerate the breakup of a slick if sea conditions or logistical support should prevent effective containment and recovery of oil at the spill site and the consequent spill movement of the spill threatens shorelines or biologically important areas. A second line of defense could be set up near the shoreline or near biologically important areas, where efforts would concentrate on diverting the oil from the shorelines or sensitive areas and diverting wildlife away from a potential area of contamination. In the event oil contaminated a shoreline, efforts would be concentrated on removing the oil and oil-contaminated materials from the shoreline.

Numerous spill-response measures have been identified for use offshore Alaska. These measures may involve efforts in eight major categories: detection, containment, recovery, in situ burning, chemical application, shoreline cleanup, wildlife protection and rehabilitation, and disposal.

Visual observation is the primary method of spill detection for exploratory operations in Alaska. In the arctic, the presence of solid-ice cover and limited visibility due to extended periods of darkness, fog, and blowing snow reduce the effectiveness of visual detection of a spill, especially for spills from pipelines under solid ice. For this reason, Industry- and Government-sponsored research has concentrated on developing systems for detecting oil under ice and for remote sensing of oil on the water's surface during periods of darkness and reduced visibility. Remote-sensing systems are currently available, but none have conclusively demonstrated the ability to detect oil spilled in broken ice. Acoustic systems have been developed for detecting oil under ice, but additional improvements of these systems are necessary before acceptable results can be expected.

The effectiveness of booms to contain oil for recovery operations or to divert oil as a protective measure would vary greatly, depending on the environmental conditions during the operation. Increasing waves, sea states, and currents would decrease the amount of oil that could be contained by a boom; and moving ice would prohibit the effective use of conventional booms unless some method of diverting the ice from the boom is developed. Calm-water booms could be used to contain oil through an international sea state of 1 (significant wave height to 1 ft [0.3 m]); harbor booms through an international sea state of 2 (significant wave height to 2.9 ft [0.9 m]); and offshore booms, with some success, through an international sea state of 4 or higher (significant wave height to 6.9 ft [2.1 m]). Other booms can be categorized by their special use, such as sorbent booms, fire-resistant booms, and ice-deflecting booms.

Offshore testing of booms in higher sea states is scheduled to begin in September 1987. Recent emphasis has been placed on the development of fire-resistant booms, and booms are currently available in Alaska that can withstand 24 hours of burn and contain oil in 2-foot seas.

Research is now underway to develop containment and herding systems for broken ice. Two prototype systems that show promise are bubble barriers and high-pressure-waterjet herding systems.

A wide variety of portable, vessel-mounted, and vessel-skimming systems are available for open-water use in Alaska. The effectiveness of skimming systems depends on the oil type, the encounter rate, and the environmental conditions during operation; skimmer performance usually is reduced by high sea states, strong currents, viscous oils, and the presence of ice or other debris. Small, portable skimmers generally are used to recover oil that has been contained by booms or natural features, such as melt pools or ice. Large, vessel-mounted skimming systems and vessel skimmers are designed to advance through a slick or for use on the windrows of oil that may form in persistent winds and sea states where containment booming is not feasible. With today's technology, the upper limit for mechanical recovery of oil under open-ocean conditions is 8 to 10 feet (2.4-3.1 m). Recovery rates for major skimming systems currently located in Alaska range from 200 to 600 barrels (31.8 to 95.4 m^3) per hour. Recovery rates, however, are not indicative of expected encounter rates, which would be significantly less.

Historically, the total spill-recovery rate has been low. Estimated recovery for individual spills ranges from less than a 10- to 70-percent-recovery rate for spills at sea. Under solid-ice conditions, total spill recovery is much better. Estimates range as high as 95 percent for spills onto the surface of solid ice during the winter months. For broken ice and ice that cannot support mechanical recovery techniques, in situ burning is the primary response method; and preliminary analysis indicates that burn efficiencies as high as 80 to 90 percent are possible. Mechanical recovery, however, can be useful in open water, in leads, and near structures where in situ burning may pose a threat. In a recent evaluation for the State of Alaska, S.L. Ross concluded that approximately 8 percent of a major spill could be recovered by mechanical methods during broken-ice conditions (S.L. Ross, 1983).

Industry has adopted in situ burning as the primary response technique for potential major oil spills in the arctic. Numerous studies and field trials have been conducted to determine the effectiveness of this technique, which is expected to be quite effective for spills that are concentrated in a small area. When the oil can be burned near the source before it is allowed to spread and before it has had the opportunity to form emulsions, burn efficiencies as high as 90 percent can be expected. Oil slicks that are too thin to support combustion may be concentrated by using a fire-resistant boom to allow the burning of the oil. Waves and wind may reduce the effectiveness of burns. In situ burning is ideally suited for massive spills in remote areas, such as those that might occur from a tanker accident in the Bering Sea.

Oil that is trapped under the ice or encapsulated in arctic seasonal ice can be successfully burned in situ in the spring and summer when the oil rises to the surface in melt pools. If the oil contamination is widely scattered and distributed over a large area, the requirements for air-deployable ignitors and helicopters may be quite extensive, resulting in logistical problems. In situ burning of oil spilled under or encapsulated in multiyear ice may not be as successful because the oil may take several seasons to surface. Oil trapped in Bering Sea ice will be released as the ice melts. In situ burning may not be very effective unless the oil is concentrated. Research is currently underway to improve methods to initiate in situ burning. This research includes the use of lasers and other incendiary devices that may reduce the logistical constraints for in situ burning.

The use of dispersants to break up an oil slick and distribute the oil into the water column and sediments has long been a controversial subject. Dispersants work well in laboratory tests, but there has not been enough opportunity to determine their effectiveness on major offshore spills or in cold water and in the presence of ice. Permission to use dispersants must be obtained from the USCG On-Scene Coordinator, with the concurrence of the EPA and State of Alaska representatives to the Regional Response Team. Historically, such permission has been difficult to obtain in a timely manner; and efforts currently are under way in Alaska to develop guidelines for dispersant use offshore Alaska.

Many shorelines can be effectively cleaned of stranded oil. The shorelines that are easiest to clean are sand and gravel beaches where heavy equipment can operate to remove the contaminated sediments. The most difficult areas to clean are marshes, tundra, and areas of low load-bearing capacity that require extensive manual labor. Shoreline cleanup is very time-consuming, labor-intensive, and costly. Logistics and accessibility are expected to hinder shoreline cleanup in Alaska.

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Wildlife protection and rehabilitation can be categorized into four areas: booming to prevent oil from entering a sensitive area, dispersing the oil to prevent it from contacting and adhering to sensitive shorelines and surface wildlife, using scare techniques to move the wildlife from the area that may become contaminated with oil, and cleaning oil-contaminated animals. Diversion and protective booming are effective only under good-weather conditions in calm to moderate sea states. Dispersion, both natural and chemically induced, has the potential to be an effective response measure to protect sensitive shorelines and some wildlife. To date, scare techniques have been mostly limited to birds. Rehabilitation methods for oil-contaminated birds have been established through previous experience, but success rates (survival of rehabilitated birds) are very low. Rehabilitation of other oiled wildlife has not been well established, although some marine mammals may be able to recover on their own. Rehabilitation efforts may induce stress or cause behavioral changes, hindering success rates.

Storage and disposal of oil and oil-contaminated material is a major consideration for large offshore spills. In Alaska, a temporary storage capacity of approximately 3,000 (477 m^3) barrels is available through the use of collapsible storage containers and other storage containers maintained by Alaskan spill cooperatives. Additional storage capacity would be available through the use of barges and tankers, which would have to be obtained and brought to the spill area. However, effective *in situ* burning would eliminate much of the need for temporary storage and disposal facilities; and dispersion, either natural or chemically induced, can be thought of as a disposal method. Natural dispersion is quite effective with some oils under high sea states.

Other effective tools to dispose of recovered oil and oil-contaminated materials are incinerators and flare burners. Burning systems that presently are readily available can dispose of from 5,000 to 6,000 barrels (795 to 954 m^3) of oil per day.

Among other disposal methods are reclamation, injection, and burial. However, the lack of approved burial sites within the State limits preplanning efforts for disposal of oily wastes by burial.

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APPENDICES

APPENDIX A

MINERALS MANAGEMENT SERVICE, ALASKA OCS REGION

OCS ORDER NO. 7

UNITED STATES
DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE

ALASKA OCS REGION

OCS ORDER NO. 7

EFFECTIVE NOVEMBER 22, 1982

POLLUTION PREVENTION AND CONTROL

This OCS Order is issued pursuant to the authority prescribed in 30 CFR 250.10 and 250.11 and in accordance with 30 CFR 250.43. The lessee shall comply with the following requirements:

1. Pollution Prevention. During the exploration, development, production, and transportation of oil and gas, the lessee shall prevent pollution of the ocean. Furthermore, by the disposal of waste materials into the ocean, the lessee shall not create conditions which will adversely affect the public health, life, property, aquatic life, wildlife, recreation, navigation, fishing, or other uses of the ocean.

1.1 Liquid Disposal.

1.1.1 Drilling-Mud Components. The lessee shall submit, as a part of the Application for Permit to Drill (Form 9-331 C), a detailed list of drilling-mud components including the common chemical or chemical trade name of each component, a list of the drilling-mud additives anticipated for use in meeting special drilling requirements, and the proposed method of drilling-mud disposal. The disposal of drilling mud is subject to the Environmental Protection Agency's permitting procedures pursuant to the Federal Water Pollution Control Act, as amended. Approval of the method of drilling-mud disposal into the ocean shall be obtained from the District Supervisor; each request will be decided on a case-by-case basis.

1.1.2 Hydrocarbon-Handling Equipment. All hydrocarbon-handling equipment for testing and production such as separators, tanks, and treaters shall be designed and operated to prevent pollution. Maintenance or repairs which are necessary to prevent pollution of the ocean shall be undertaken immediately.

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1.1.3 Curbs, Gutters, and Drains.

1.1.3.1 Fixed Platforms and Structures. Curbs, gutters, drip pans, and drains shall be installed in all deck areas in a manner necessary to collect all contaminants and piped to a properly designed, operated, and maintained sump system which will automatically maintain the oil at a level sufficient to prevent discharge of oil into OCS waters. Sump piles shall not be used as processing devices to treat or skim liquids but shall be used to collect treated produced water, treated sand, liquids from drip pans and deck drains, and as a final trap for hydrocarbon liquids in event of equipment upsets. Improperly designed, operated, or maintained sump piles which do not prevent the discharge of oil into OCS waters shall be replaced as required by the District Supervisor.

1.1.3.2 Artificial Islands. On artificial islands, all vessels containing hydrocarbons shall be placed inside a berm lined with an impervious material. The volume enclosed by the berm shall be in excess of the volume of vessels containing hydrocarbons. In addition, all drainage ditches shall be directed away from the drilling rig to a sump. The rig mat, the drainage ditches, and sumps shall be lined with impervious material.

1.1.3.3 Mobile Drilling Units. Curbs, gutters, and drains which collect contaminants associated with the drilling operation on a mobile drilling unit shall be installed as required by subparagraph 1.1.3.1. Curbs, gutters, and drains which collect contaminants not associated with the drilling operation are subject to regulation by the U.S. Coast Guard.

1.1.4 Discharges from Fixed Platforms, Structures, Artificial Islands, and Mobile Drilling Units. Discharges from fixed platforms, structures, artificial islands, and mobile drilling units, including sanitary waste, produced water, drilling mud, and deck drainage, are subject to the Environmental Protection Agency's permitting procedures pursuant to the Federal Water Pollution Control Act, as amended.

1.2 Solid Material Disposal.

1.2.1 Well Solids. The disposal of drill cuttings, sand, and other well solids containing oil is subject to the Environmental Protection Agency's permitting procedures pursuant to the Federal Water Pollution Control Act, as amended. Approval of the method of disposal of drill cuttings, sand, and other well solids shall be obtained from the District Supervisor.

1.2.2 Containers. Containers and other similar solid waste materials shall not be disposed of into the ocean.

1.2.3 Equipment. Disposal of equipment into the ocean is prohibited except under emergency conditions. The location and description of equipment disposed of into OCS waters shall be reported to the U.S. Coast Guard in accordance with paragraph 4 of OCS Order No. 1.

2. Personnel, Inspections, and Reports.

2.1 Personnel. The lessee's personnel shall be instructed in the techniques of equipment maintenance and operation for the prevention of pollution. Contractor personnel providing services offshore shall be informed in writing, prior to executing contracts, of the lessee's obligations to prevent pollution and of the provisions of this Order.

2.2 Pollution Inspections.

2.2.1 Manned Facilities. Manned drilling and production facilities shall be inspected daily to determine if pollution is occurring. Maintenance or repairs which are necessary to prevent pollution of the OCS waters shall be undertaken and performed immediately.

2.2.2 Unattended Facilities. Unattended facilities, including those equipped with remote control and monitoring systems, shall be inspected daily or at intervals prescribed by the District Supervisor to determine if pollution is occurring. Daily inspections may be postponed in the event of adverse weather conditions. Necessary maintenance or repairs shall be made immediately.

2.3 Pollution Reports. All spills of oil and liquid pollutants shall be reported orally to the District Supervisor and shall be confirmed in writing. All reports shall include the cause, location, volume of spill, and action taken. Reports of spills of more than 5.0 cubic meters (31.5 barrels) shall include information on the sea state, meteorological conditions, size, and appearance of slick. All spills of oil and liquid pollutants shall also be reported to the U.S. Coast Guard in accordance with the procedures contained in 33 CFR 135.305 and 135.307.

2.3.1 Spills. Spills shall be reported orally within the following time limits:

a. Within 12 hours, if spills are 1.0 cubic meters (6.3 barrels) or less; or

b. Without delay, if spills are more than 1.0 cubic meters (6.3 barrels).

2.3.2 Observed Malfunctions. Lessees shall notify each other of observed pollution resulting from another's operation.

3. Pollution-Control Equipment and Materials and Oil Spill Contingency Plans. The lessee shall submit a description of procedures, personnel, and equipment that will be used in reporting, cleanup, and prevention of the spread of any pollution resulting from an oil spill which might occur during exploration or development activities. The following subparagraphs describe the minimum requirements for pollution-control equipment and procedures.

3.1 Equipment and Materials. Pollution-control equipment and materials shall be maintained by, or shall be available to, each lessee at an offshore location or at a location approved by the Regional Supervisor (RS), Offshore Field Operations. The equipment shall include containment booms, skimming apparatus, cleanup materials, chemical agents and other items needed for the existing climatic conditions, and shall be available prior to the commencement of drilling and production operations. The equipment and materials shall be inspected monthly and maintained in a state of readiness for use. The results of the inspections shall be recorded and maintained at the site.

3.2 Oil Spill Contingency Plans. The lessee shall submit an Oil Spill Contingency Plan for approval by the RS, Offshore Field Operations, with or prior to submitting an Exploration Plan or a Development and Production Plan. Oil Spill Contingency Plans shall be reviewed annually. All modifications of the Oil Spill Contingency Plan and the results from the review of the plan shall be submitted to the RS, Offshore Field Operations, for approval. The Oil Spill Contingency Plan shall contain--

a. Provisions to assure that full resource capability is known and can be committed during an oil spill, including the identification and inventory of applicable equipment, materials, and supplies which are available locally and regionally, both committed and uncommitted, and the time required for deployment of the equipment;

b. Provisions for varying degrees of response effort depending on the severity of the oil spill;

c. Provisions for identifying and protecting areas of special biological sensitivity;

d. Establishment of procedures for the purpose of early detection and timely notification of an oil spill including a current list of names, telephone numbers, and addressees of the responsible persons and alternates on call to receive notification of an oil spill, and the names, telephone numbers, and addresses of regulatory organizations and agencies to be notified when an oil spill is discovered; and

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e. Provisions for well-defined and specific actions to be taken after discovery and notification of an oil spill, including--

(1) Specification of an oil spill response operating team consisting of trained, prepared, and available operating personnel;

(2) Predesignation of an oil spill response coordinator who is charged with the responsibility and is delegated commensurate authority for directing and coordinating response operations;

(3) A preplanned location for an oil spill response operations center and a reliable communications system for directing the coordinated overall response operations; and

(4) Provisions for disposal of recovered spill materials.

4. Drills and Training.

4.1 Drills. Drills for familiarization with pollution-control equipment and operational procedures shall be the lessee's responsibility and shall be held at least once every 12 months by the lessee or a contractor serving the lessee. The personnel identified as the oil spill response operating team in the Contingency Plan shall participate in these drills. The drills shall be realistic and shall include deployment of equipment. A time schedule with a list of equipment to be deployed shall be submitted to the RS, Offshore Field Operations, for approval. The drill schedule shall provide sufficient advance notice to allow Minerals Management Service (MMS) personnel to witness any of the drills. Drills shall be recorded, and the records shall be made available to MMS personnel. Where drill performance and results are deemed inadequate, the RS, Offshore Field Operations, may require an increase in the frequency or a change in the location of the drills until satisfactory results are achieved.

4.2 Training. The lessee shall ensure that training classes for familiarization with pollution-control equipment and operational procedures are provided for the oil spill response operating team. The supervisory personnel responsible for directing the oil spill response operations shall receive oil spill control instruction suitable for all seasons. The lessee shall retain course completion certificates or attendance records issued by the organization where the instruction was provided. These records shall be available to any authorized representative of the MMS upon request.

5. Spill Control and Removal. Immediate corrective action shall be taken in all cases where pollution has occurred. Corrective action taken under the lessee's Oil Spill Contingency Plan shall be subject to modification when directed by the RS, Offshore Field

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Operations. The primary jurisdiction to require corrective action to abate the source of pollution shall remain with the RS, Offshore Field Operations, pursuant to the provisions of this Order and the Memorandum of Understanding (MOU) between the Department of Transportation (U.S. Coast Guard) and the Department of the Interior (U.S. Geological Survey), dated August 16, 1971. The use of chemical agents or other additives shall be permitted only after approval by the RS, Offshore Field Operations, in accordance with Annex X, National Oil and Hazardous Substances Pollution Contingency Plan, and in accordance with this MOU.

6. Departures. All departures from the requirements specified in this Order shall be subject to approval pursuant to 30 CFR 250.11(b).

Rodney A. Smith

Rodney A. Smith
Regional Supervisor
Offshore Field Operations

Approved: August 3, 1982
(47 FR 47180, October 22, 1982)

Robert L. Rioux

Robert L. Rioux
Associate Director for
Offshore Minerals Management

APPENDIX B

MINERALS MANAGEMENT SERVICE, ALASKA OCS REGION PLANNING GUIDELINES FOR APPROVAL OF OIL-SPILL-CONTINGENCY PLANS

July 29, 1982

UNITED STATES DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
ALASKA OCS REGION

PLANNING GUIDELINES FOR APPROVAL OF OILSPILL CONTINGENCY PLANS

The following guidelines have been developed in accordance with the Minerals Management Service (MMS)/U.S. Coast Guard (USCG) Memorandum of Understanding (MOU) dated December 18, 1980. These guidelines are in addition to the Oilspill Contingency Plan requirements contained in 30 CFR 250.34, OCS Orders, and other legal requirements of agencies involved.

These guidelines supersede the Notice to Lessees 81-1 Criteria for Approval of Oilspill Contingency Plans - Beaufort Sea.

a. Risk Analysis: The contingency plan should contain an analysis which indicates the number and size of spills that could occur during OCS mineral exploration, development, and production operations. The spill trajectory analysis should indicate where an oilspill is likely to flow under the various expected sets of local, seasonal, meteorological, and oceanographic conditions. Impact areas should be identified, and strategies should be fully developed for the protection of environmentally sensitive areas and potentially vulnerable resources. The depth of detail is flexible but should be sufficient to assure the On-Scene Coordinator (OSC) that adequate contingency planning has been done.

b. Recovery Equipment: The type of recovery equipment and its method of deployment rest entirely with the operator. However, subject to the prevalent conditions identified in the risk analysis, the equipment should be "state-of-the-art." Based on previous research and development studies, observations, and experiences, currently available "state-of-the-art" equipment is capable of operating in 8- to 10- foot seas and 20-knot winds, with deployment accomplished in the 5- to 6-foot range. However, the OSC should be aware that mechanical equipment cannot be expected to perform at optimum efficiencies in all environmental situations. Local conditions, such as high energy sea states with short wave lengths or severe icing, may not allow all of the above operational criteria to be met.

c. Equipment Availability: The quantity and capability of the equipment to be made available should be related to the risk analysis. For planning purposes, open-water recovery devices typically have a recovery capacity of at least 1000 barrels/day. A recovery rate of 1000 barrels/day should therefore be considered appropriate, unless the risk analysis suggests a higher spill rate is likely. This recovery

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rate may be attained from one device or an array of devices which would be utilized in concert with each other. The contingency plan should also indicate how additional equipment will be made available for extraordinary spills, that is, spills that exceed the recovery capacity of the readily available equipment.

d. Response Time: If local conditions or geography permit, the target for initiating recovery operations with pre-staged equipment (i.e., the response time) should be 6 to 12 hours from the time of the spill, dependent upon the location and general operating characteristics of the drilling or production activity. If the Risk Analysis indicates that an oilspill will contact a shoreline sooner than 6 to 12 hours, the response times should be reduced to ensure response prior to contact. Whatever amount of equipment is required to be available for responding to spills should be fully deployed and in operation within the specified response time, weather permitting. The location of staged equipment will be left to the operator. For extraordinary spills, the operator should be expected to obtain additional equipment within 48 hours.

e. Drills: Response exercises for deploying equipment in open water shall occur at least annually to test the equipment and the contingency plan. This exercise should be held in the area of operations under realistic environmental conditions in which deployment and operation can be accomplished without endangering the safety of personnel. In addition, at least one hands-on drill should be conducted annually as part of a training program and may include full deployment conducted in protected waters. Additional drills will be required if drilling operations continue into new seasonal environmental conditions. Exercises that test the alerting/initial response mechanism and command, control, and communications should be held as frequently as necessary to demonstrate effectiveness to the OSC.

f. Support Vessels: Vessels or vessel types to be used in deploying and operating the response equipment should be identified in the contingency plan. The vessels should be available within the same response time parameters as specified for response equipment. The crews of all candidate support vessels should be familiar with equipment deployment and operating techniques or a system should be developed to supply trained crews and supervisors to the support vessels within the specified response time.

g. Dispersant Equipment: In addition to oil recovery equipment, dispersant equipment should be included in the contingency plan. Equipment capable of applying dispersants should be maintained at appropriate staging points, as well as adequate stockpiles of dispersants if they are not readily available from local distributors. The types and toxicities of dispersants proposed for use should be identified in the contingency plan. The quantity and types of dispersants presited should be related to the risk analysis, taking

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into account dispersant toxicity, oil composition, and water temperature. The above should not be interpreted as a predilection on the part of Government for the use of dispersants, but a recognition that spills may occur when, due to environmental conditions or lack of adequate support resources, mechanical recovery is not possible. The decision to use dispersants would of course be made using the criteria and procedures set forth in the National Oil and Hazardous Substances Pollution Contingency Plan. A response target of 24 hours from the time the spill occurs is appropriate, unless preapproved contingency plans or a streamlined Regional Response Team authorization procedure for the use of dispersants are in effect. In that event, the response time may be lessened.

h. Authority: An operator's representative must be identified who has the authority to order ignition of an uncontrollable well which is causing a massive spill event. The guidelines by which this individual will make the decision to ignite the well must be submitted.

i. Disposal: The contingency plan should describe proposed methods and sites, including storage capacity, for interim and ultimate disposal of recovered oil, oil-contaminated material, and other oily wastes.

j. Detection and Monitoring: The contingency plan should provide for detection of an oilspill and for monitoring of its movement. If electronic or mechanical instrumentation is used, threshold detection sensitivities and limitations of equipment must also be provided.

k. Any provisions of OCS Orders dealing with contingency planning, the provision, use, and maintenance of pollution control equipment, or related training, also shall apply in the preparation of contingency plans.

Any comments regarding these guidelines should be directed to:

Deputy Minerals Manager
Offshore Field Operations
Minerals Management Service
800 A Street
Anchorage, Ak. 99501
(907) 271-4303

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APPENDIX C

MEMORANDUM OF UNDERSTANDING BETWEEN THE DEPARTMENT OF THE INTERIOR AND THE DEPARTMENT OF TRANSPORTATION REGARDING ACTIVITIES ON THE OUTER CONTINENTAL SHELF

Billing Code: 4310-31

DEPARTMENT OF THE INTERIOR, U.S. Geological Survey

DEPARTMENT OF TRANSPORTATION, U.S. Coast Guard

Memorandum of Understanding

AGENCIES: U.S. Geological Survey, Department of the Interior
U.S. Coast Guard, Department of Transportation

ACTION: Final Document

SUMMARY: The U.S. Geological Survey and the U.S. Coast Guard have signed a new Memorandum of Understanding (MOU) to promote the safety of activities and facilities on the Outer Continental Shelf (OCS) of the United States associated with the exploration, development, and production of mineral resources, to avoid duplication of effort, and to promote consistent, coordinated, and less burdensome regulation of these facilities. This MOU may identify changes required in individual regulations, or modifications to the OCS regulatory scheme, or both. This MOU is in response to the enactment of the OCS Lands Act Amendments of 1978 (Public Law 95-372).

DATES: This MOU is effective December 18, 1980.

ADDRESSES: A copy of the MOU may be obtained from the following offices:

Deputy Division Chief
Offshore Minerals Regulation
Conservation Division
U.S. Geological Survey
640 National Center
Reston, Virginia 22092

Manager
Outer Continental Shelf Safety Project
U.S. Coast Guard (G-MP-3OCS)
2100 2nd Street, S.W.
Washington, D.C. 20593

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FOR FURTHER INFORMATION CONTACT: Mr. Price McDonald, Chief, Branch of Offshore Field Operations, Conservation Division, U.S. Geological Survey, 640 National Center, Reston, Virginia 22092, telephone (703) 860-7571.

12 4 DEC 1980

Date

Robert L. Rioux

Robert L. Rioux
Deputy Division Chief,
Offshore Minerals Regulation
Conservation Division

The Memorandum of Understanding between the USGS and the USCG is revised in its entirety to read as follows:

MEMORANDUM OF UNDERSTANDING
BETWEEN THE
UNITED STATES GEOLOGICAL SURVEY
OF THE DEPARTMENT OF THE INTERIOR
AND THE
UNITED STATES COAST GUARD
OF THE
DEPARTMENT OF TRANSPORTATION
CONCERNING REGULATION OF ACTIVITIES
AND FACILITIES ON
THE OUTER CONTINENTAL SHELF OF THE UNITED STATES

I. Purpose:

The purpose of this Memorandum of Understanding is to promote the safety of activities and facilities on the Outer Continental Shelf of the United States (OCS) associated with the exploration, development, and production of mineral resources, to avoid duplication of effort, and to promote consistent, coordinated and less burdensome regulation of these facilities.

II. Definitions:

For purposes of this Memorandum of Understanding, the following definitions apply:

Act - The Outer Continental Shelf Lands Act of 1953 (43 U.S.C. 1331 et seq.), as amended by the Outer Continental Shelf Lands Act Amendments of 1978 (Pub. L. 95-372).

Deepwater Port - A facility licensed by the Secretary of Transportation under the Deepwater Port Act of 1974.

Vessel - Every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on the water. This term does not include atmospheric or pressure vessels used for the containment of fluids or gases.

Outer Continental Shelf - The submerged lands which are subject to the Act.

OCS Activity - Any offshore activity associated with exploration for, development of, or production of mineral resources of the OCS.

OCS Facility - Any artificial island, platform, installation, or other device, permanently or temporarily attached to the seabed or subsoil of the OCS, and used for any OCS activity. This term does not include a deepwater port or vessel engaged in transportation, but does include a:

1. Fixed OCS Facility - Any fixed, bottom-founded facility permanently attached to the seabed or subsoil of the OCS, including platforms, guyed towers, articulated columns, gravity platforms and other structures;

2. Floating OCS Facility - Any buoyant facility securely and substantially moored to the seabed or subsoil of the OCS, including tension leg platforms, permanently moored semi-submersibles, ship/barge shape hulls, or other buoyant structures. This term does not include mobile offshore drilling units;

3. Mobile Offshore Drilling Unit (MODU) - Any vessel capable of engaging in drilling operations for the exploration or exploitation of mineral resources of the OCS. This term includes mobile offshore drilling units engaged in OCS activities that are U. S., foreign, or not documented under the laws of any nation;

4. OCS Terminal - Any fixed or floating facility which is used or intended for use primarily as a port or terminal for transferring produced oil, gas or other OCS mineral resources to or from a vessel;

5. Mobile Well Servicing Unit (MWSU) - Any vessel other than a MODU which engages in well servicing operations on the OCS.

III. Agency Authorities on the OCS:

A. General:

1. The Department of the Interior is responsible for management of mineral leasing on the OCS of the United States, including coordinating Federal activities related to this program. Within the Department of the Interior, the U. S. Geological Survey regulates all mineral exploration, drilling, and production activities on leased or leasable land.

2. The United States Coast Guard of the Department of Transportation regulates to promote the safety of life and property on OCS facilities and vessels engaged in OCS activities, and the safety of navigation.

B. Statutory authorities of the Geological Survey on the OCS include:

1. Providing for the prevention of waste and the conservation of the natural resources of the OCS, and the protection of correlative rights.

2. Requiring suspension or temporary prohibition of any operation or activity on a lease if there is a threat of serious or irreparable harm or damage to life, to property, to mineral deposits or to the marine, coastal, or human environment.

3. Reviewing allegations of violations of safety regulations issued under the Act.

4. Reviewing and approving exploration plans, development and production plans, and applications for permits to drill necessary for prompt and efficient exploration, development, and production of a lease area.

5. Reviewing and approving applications for remedial work on completed wells.

6. Approving rights of use and easement.

7. Inspecting drilling and production operations to ensure compliance with applicable lease terms and Geological Survey regulations and orders.

8. Ensuring compliance with the national ambient air quality standards pursuant to the Clean Air Act (42 USC 7401 et seq.), to the extent that activities authorized under the Act significantly affect the air quality of any State.

9. Exercising the Secretary of the Interior's responsibilities for the assessment, compromise, and collection of civil penalties under section 24(b) of the Act.

C. Statutory authorities of the Coast Guard on the OCS include:

1. Promoting the safety of life and property on OCS facilities and adjacent waters.

2. Requiring hazardous working conditions related to activities on the OCS to be minimized.

3. Reviewing allegations of violations of occupational safety and health regulations under the Act.

4. Administering applicable vessel navigation, safety and inspection laws contained in Titles 46 and 33 of the United States Code.

5. Inspecting OCS facilities and vessels engaged in OCS activities to ensure compliance with applicable Coast Guard requirements.

D. Similar statutory authorities involving both agencies include:

1. Establishing minimum requirements or standards of design, construction, alteration, and repair for vessels, rigs, platforms, or other vehicles or structures engaged in OCS activities.

2. Performing scheduled and unannounced inspections of OCS facilities to assure compliance with regulations promulgated pursuant to the Act.

3. Enforcing regulations promulgated pursuant to the Act, including authority to utilize by agreement the services of personnel or facilities of other Federal agencies.

4. Investigating and making public reports on deaths, serious injuries, fires, and oil spillage occurring as a result of OCS operations.

5. Requiring the use of the best available and safest technologies on OCS drilling and production operations as set forth in section 21(b) of the Act.

IV. Responsibilities:

To accomplish the purposes of this memorandum both agencies agree to observe the following guidelines with respect to overseeing OCS facility design and construction, systems and equipment, and operations.

A. Facility design and construction requirements, including plan approval:

1. The Geological Survey exercises technical review and approval responsibility for design, fabrication, and installation of all fixed OCS facilities. Additionally, after technical review and approval of the design and fabrication of all floating OCS facilities by the Coast Guard, the Geological Survey will have final approval responsibility for the installation of such facilities. The Geological Survey will coordinate technical and plan review as necessary with the Coast Guard to ensure that any applicable Coast Guard requirements affecting design or construction are complied with.

The Geological Survey verifies the following for all OCS facilities:

a. Site-specific considerations, such as oceanographic, meteorological, geological and geophysical conditions including bottom conditions and the capability of the seabed to support or hold the position of the facility to be installed and operated.

The Geological Survey establishes requirements and verifies the following for fixed OCS facilities:

b. Structural integrity involving design, fabrication, and installation;

c. General arrangement of drilling, production, and well control systems and equipment;

d. Modification and repair related to structural integrity.

2. The Coast Guard exercises technical review and approval responsibility for design and construction of all floating OCS facilities, and all vessels engaged in OCS activities, including MODUs and MWSUs. The Coast Guard will coordinate technical and plan review as necessary with the Geological Survey to ensure that any applicable Geological Survey requirements affecting design or construction are complied with.

The Coast Guard establishes requirements for the following on all OCS facilities:

a. Structural fire protection, including specifying fire endurance capabilities of bulkheads, decks, and escape routes, testing and classification of materials, and requirements for ventilation systems;

b. Access, landings and emergency escape routes.

The Coast Guard establishes requirements for the following on floating OCS facilities and vessels engaged in OCS activities:

c. Design, loading, fabrication and construction requirements;

d. Stability and buoyancy;

e. Modification and repair requirements related to structural integrity;

f. General arrangement.

B. Systems and Equipment:

Systems approved by one agency which are interconnected to systems approved by the other agency must be acceptable to both agencies.

1. The Geological Survey establishes requirements and verifies compliance with those requirements for systems and equipment for drilling, production, well control, and workover, on all OCS facilities.

Systems and equipment for which the Geological Survey establishes requirements, as necessary, on all OCS facilities include:

a. Blowout preventer and other well control equipment;

b. Surface production safety systems;

c. Emergency Shutdown System (ESD), including associated gas and fire detection systems;

d. Subsurface well-control equipment, including safety valves;

e. Atmospheric, pressure and fired vessels used for the processing of production;

f. Wellhead and flow-line equipment, including valves and sensors for wellheads, flow lines, and pipelines;

g. Dehydration equipment and gas compressor units used in production operations;

h. Hydrogen sulfide control equipment, including the hydrogen sulfide gas detection system;

i. Production and production-associated piping systems, including incoming and departing pipelines;

j. Pumps used to transfer liquids within the production process systems and into pipelines;

k. Fire Loop System which is used for detection and to initiate platform shutdown;

l. Subsea completions;

m. Wellhead fire-prevention;

n. Gas detection systems for drilling, production or gas transmission systems or equipment;

transmission systems or equipment;

o. Oil and gas sale and metering equipment for production from OCS leases;

p. Containment systems for overflow from equipment associated with drilling and production.

Other systems and equipment for which the Geological Survey is responsible on fixed facilities include:

q. Electrical system design and equipment, including designation of classified locations;

r. Pressure vessels and piping associated with drilling operations;

s. Engine exhaust insulation and spark arrestors.

2. The Coast Guard establishes systems and equipment requirements, as appropriate, for propulsion machinery, auxiliary machinery and personnel safety equipment on all OCS facilities. The Coast Guard also establishes requirements for equipment on all OCS facilities to mitigate occupational safety or health hazards, or ensure the seaworthiness of a MODU, MWSU, floating OCS facility, or vessel. However, the Coast Guard will not establish requirements for drilling, production or workover equipment that would duplicate or conflict with Geological Survey requirements. Nor will the Coast Guard establish requirements for safety factors, shutdown or relief valves for pressure vessels or piping in systems for which Geological Survey has design approval.

Systems and equipment for which the Coast Guard establishes requirements, as necessary, on all OCS facilities include:

a. Lifesaving systems and equipment;

b. Fire detection, control and extinguishing systems and equipment not covered under IV. B. 1. (c) and (k) of this Memorandum;

c. General alarms;

d. Cranes, booms or other material handling equipment, including industrial trucks;

e. Personnel protection equipment, excluding equipment for protection from hydrogen sulfide;

f. Communications;

g. Helicopter fueling facilities;

h. Helicopter deck installations;

i. Navigation lights, obstruction lights, and sound signals;

j. Boilers, pressure vessels, and piping not covered under IV B. 1. of this Memorandum;

k. Underwater working chambers designed for human occupancy and their support systems;

l. Hotel services including fresh water, flushing water, heating systems, etc.;

m. Permanent and portable quarters.

Other systems and equipment for which the Coast Guard establishes requirements, as necessary, on floating OCS facilities, MODUs, MWSUs, and vessels include:

n. Electrical system design and equipment, including designation of classified areas;

o. Mooring systems.

Other systems and equipment for which the Coast Guard establishes requirements, as necessary, on OCS terminals include:

p. Oil transfer, gas inerting and vapor recovery systems.

C. Operations:

1. The Geological Survey administers procedures, including training, drills, inspections and emergency procedures on all OCS facilities with respect to:

   a. Drilling, workover, and production operations, including well control;

   b. Pollution prevention, except for transfers to or from a vessel (as vessel is defined in section II. of this Memorandum);

   c. Safe welding, burning and hot tapping procedures;

   d. Control of hydrogen sulfide;

   e. Pipeline operations associated with an OCS facility;

   f. Well-head and platform removal.

Other procedures which the Geological Survey administers on OCS fixed facilities include:

   g. Underwater and above water structural inspection and repair.

2. The Coast Guard administers requirements, including those for training, drills, inspections and emergency procedures, on all OCS facilities for:

   a. Firefighting;

   b. Emergency egress from a facility, including use of lifesaving and other general emergency equipment;

   c. Handling, transfer and stowage of explosives, radioactive, flammable (other than produced hydrocarbons), and other hazardous materials;

   d. Transfer of petroleum and other products from or to a vessel (as vessel is defined in section II. of this Memorandum);

   e. Transfer of materials and personnel on or off the facility by crane or other means;

f. Vehicle and vessel operations;

g. Helicopter operations on OCS facilities;

h. Occupational safety and health of personnel;

i. Diving operations.

Other requirements which the Coast Guard administers on OCS floating facilities and vessels include:

j. Underwater and above water structural inspection and repair;

k. Stability considerations.

V. Inspections:

A. Each agency will conduct scheduled and unannounced inspections, as necessary, to ensure compliance with its own requirements. Both agencies will coordinate inspections to minimize disruption of operations. If, in the course of a routine inspection, deficiencies falling within the responsibility of the other agency are apparent, the deficiencies will be reported to the other agency for action. This is not intended, however, to prevent any inspector from either agency from taking such action as is considered necessary to prevent serious or irreparable harm to persons, property or the environment on the OCS. Such action, however, will be subsequently reported to the other agency.

B. The Geological Survey administers procedures for requiring shut-down of drilling and production operations and may initiate such procedures upon request by the Coast Guard.

C. The Coast Guard issues certificates indicating compliance with Coast Guard requirements for all floating OCS facilities and vessels engaged in OCS activities, including MODUs and MWSUs.

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VI. Investigations:

A. Responsibility:

Investigation and public report by the Geological Survey or the Coast Guard are required for fires, oil pollution, deaths and injuries associated with OCS activities. In addition, the agencies investigate certain other incidents relating to other regulatory responsibilities, e.g. loss of well control, sinking, capsizing, or major damage to a vessel or facility. To avoid duplicative efforts and simplify administration, the primary agency regulating a particular facility, system, or operation will be responsible for leading the investigation and reporting on incidents involving that facility, system, or operation. Where only one agency has an investigative interest in an incident, that agency will investigate and report. Where both agencies have investigative interest in an incident, one agency will assume lead responsibility with supporting participation by the other agency. Assumption of lead agency responsibility, the extent of supporting participation, and procedures for coordination will be determined by the circumstances of the particular incident. Normally, all investigations which involve both agencies will be coordinated by applying the following guidelines in numerical order to determine lead agency.

B. Guidelines:

1. Collisions - The Coast Guard will normally be the lead agency.

2. Fires and Explosions - The Geological Survey will normally be the lead agency for incidents of fires or explosion involving drilling or production operations. Coast Guard participation will be requested in all investigations of fires or explosions that involve death or injuries or vessels, equipment, or operations for which the Coast Guard is responsible under paragraphs IV. B.2. or C.2. of this Memorandum.

3. Deaths and Injuries - The Coast Guard will normally be the lead agency for all incidents involving death or injuries. Geological Survey participation will be requested in investigations of all deaths and injuries associated with oil or gas drilling or production operations or equipment, including hydrogen sulfide exposure.

4. Pollution - The Geological Survey will normally be the lead agency for incidents involving pollution from all OCS facilities. Coast Guard participation will be requested in all investigations of pollution.

5. Facilities, Material and Equipment.

a. The Coast Guard will normally be the lead agency for incidents involving damage to MODUs, MWSUs, or other vessels, or floating OCS facilities, and failure of or damage to propulsion, auxiliary, or emergency systems and equipment covered under IV. B.2. of this Memorandum.

b. The Geological Survey will normally be the lead agency for all other incidents involving failure of or damage to fixed OCS facilities.

C. Conduct of Investigations:

1. The lead agency responsible for an investigation under these guidelines will conduct, review, approve and release the investigation report in accordance with the normal procedures of that agency. Comments by the supporting agency will be included in the investigation report.

2. If both agencies participate in an investigation, the lead agency will forward an information copy of the final report to the supporting agency.

3. Reports prepared by a single agency need not be routinely forwarded to the other agency, but will be available upon request.

VII. Oil Spill Contingency Plans:

Exploration Plans or Development and Production Plans are submitted to the Geological Survey for review and approval. The Coast Guard will provide a technical review of that portion of the Plan which addresses the adequacy of the oil spill contingency plan, including the adequacy of oil spill response, clean up equipment, and procedures. The criteria by which to judge the adequacy of a plan will be jointly agreed upon by the Geological Survey and the Coast Guard.

VIII. Exchange of Services and Personnel:

To the extent its own operations permit, each agency will provide the other agency with such assistance, technical advice and support, including transportation, as may be requested. Such exchange of services and use of personnel shall be on a non-reimbursable basis.

IX. Cooperation in Standards and Regulation Development:

A. Both agencies will exchange data and study results, participate in research and development projects of mutual interest, and exchange early drafts of rulemaking notices.

B. Both agencies will review current standards, regulations and orders and will propose revisions to them as necessary in keeping with the provisions of this Memorandum of Understanding.

C. Both agencies will review reporting and data collection requirements imposed on operators of OCS facilities and, wherever feasible, will eliminate or minimize duplicate reporting and data collection.

X. Implementation:

A. Each agency will review its internal procedures and where appropriate, will revise them to accommodate the provisions of this Memorandum of Understanding. Each agency will also designate one senior official who will be responsible for continuing coordination and implementation of the provisions of this Memorandum of Understanding .

B. On the effective date of this agreement, the Coast Guard/Geological Survey Memorandum of Understanding for mobile offshore drilling units, dated April 11, 1977, is cancelled.

XI. Savings Provision:

Nothing in this Memorandum of Understanding shall be deemed to alter, amend, or affect in any way the statutory authority of the Geological Survey or the Coast Guard.

XII. Effective Date:

This Memorandum of Understanding is effective upon signature. It may be amended at any time by mutual written agreement of both agencies and may be terminated by either agency upon 30 days written notice.

Signed at Washington, DC this 18th day of December 1980.

J B Hayes

J. B. Hayes
Commandant, U. S. Coast Guard
Department of Transportation

HW Menard

H. William Menard
Director, U. S. Geological Survey
Department of the Interior

DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

DEPARTMENT OF TRANSPORTATION
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20590

MEMORANDUM OF UNDERSTANDING BETWEEN THE DEPARTMENTS OF THE INTERIOR AND TRANSPORTATION CONCERNING RESPECTIVE RESPONSIBILITIES UNDER THE NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTINGENCY PLAN.

In order to assure the most efficient use of resources under the National Oil and Hazardous Substances Pollution Contingency Plan, the Secretaries of the Departments of the Interior and Transportation agree that the following provisions shall be observed by the agencies of the two Departments in the exercise of their authority and the discharge of their responsibilities under the Contingency Plan.

1. The U.S. Geological Survey has the expertise and capability for coordination and direction in respect to measures to abate the source of pollution when the source is an oil, gas, or sulfur well.

2. The U.S. Coast Guard has the expertise and capability for coordination and direction in respect to measures to contain and remove pollutants.

3. With respect to spills originating from operations conducted under the Outer Continental Shelf Lands Act of 1953, the U.S. Coast Guard shall furnish or provide for the On Scene Coordinator (OSC) with authority and responsibilities as provided by the National Contingency Plan subject to the following qualifications:

a. The authorized representative of the U.S. Geological Survey on the scene shall have the exclusive authority with respect to coordination and direction of measures to abate the source of pollution.

b. The authorized representative of the U.S. Geological Survey on the scene shall make the determination, which shall be binding upon the On Scene Coordinator, that pollution control activities within a 500 meter radius of the source of pollution should be suspended to facilitate measures to abate the source of pollution.

c. The authorized representative of the U.S. Geological Survey on the scene shall make the determinations necessary under Section 250.43 of Title 30 of the Code of Federal Regulations, which shall be binding upon the On Scene Coordinator.

d. In regard to those matters arising under Section 1334 et seq. of Title 43 of the U.S. Code and the regulations and Outer Continental Shelf Orders issued thereunder, the On Scene Coordinator shall communicate with the lessee through the authorized representative of the U.S. Geological Survey on scene.

e. The On Scene Coordinator and the authorized representative of the U.S. Geological Survey on scene shall maintain close liaison in all matters.

4. With respect to spills originating from operations conducted under the Submerged Lands Act of 1953 or in internal waters of the United States, the U.S. Geological Survey, upon request of the U.S. Coast Guard, will furnish expertise, guidance, and such other assistance as may be appropriate in respect to measures to abate the source of pollution when the source is an oil, gas, or sulfur well.

5. This memorandum of understanding shall be reviewed annually and shall continue in force until it shall be amended or terminated by mutual agreement.

Done this Sixteenth day of August, 1971, at the City of Washington, D. C.

FOR THE DEPARTMENT OF THE INTERIOR UNDER SECRETARY OF INTERIOR	FOR THE DEPARTMENT OF TRANSPORTATION UNDER SECRETARY OF TRANSPORTATION
WILLIAM T. PECORA	JAMES M. BEGGS

APPENDIX D

SPILL-RESPONSE-EQUIPMENT LISTING

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ALASKA CLEAN SEAS EQUIPMENT

SOURCE: Alaska Clean Seas Contingency Planning Manual, as revised, September 1986.

ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item		QUANTITY BY LOCATION		
	Deadhorse	Nome*	Dutch Harbor*	Anchorage
DETECTION				
Gas/Oxygen Detectors	2			
Gas Analyzer	1			
MSA Gas/O^2 Alarm Mod 269			1	
Current Meter	1			
Current Meter w/recorder	1			
Ice Augers	8			
Orion Tracking System	1 system	1 system	1 system	
Marker Stakes	1,000			
IBM PC - Trajectory Modeling				1
Data base for Trajectory Modeling	1	1	1	
CONTAINMENT				
Goodyear Sea Sentry Heavy Duty	2,035'			
Ocean Dike	5,400'			
EPI Mini Boom	3,000'			

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION Deadhorse	Nome*	Dutch Harbor*	Anchorage
American Marine Simplex	3,000'			
Kepner Reel Pak	4,000'	1,000'		
Whittaker Expandi Boom		1,500'	3,000'	
Acme Corral Boom on 3 trlrs			3,000'	
Boom Marker Lights			20	
25# Mooring Systems	4 boxes			
40# Mooring Systems	10 boxes			
Fire Containment Boom (2)	2,500'			
RECOVERY				
ARCAT II w/12 man life raft	1			
3M Sorbent Boom Type 280	250 bales			
3M Sorbent Rolls Type 100	507 rolls	12 rolls	12 rolls	17 rolls
3M Sorbent Pads Type 151	269			
3M Sorbent Pads Type 157	400 bales			

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION Deadhorse	Nome*	Dutch Harbor*	Anchorage
3M Sorbent Boom Type 270		60 bales	60 bales	
3M Sorbent Type 156				32 bales
3M Sorbent Type 126				10 bales
3M Sorbent Type 356C	85 boxes			
Conweb Sorbent Blanket				50 bales
Conweb Sorbent Pads				19 bales
MI-30 Disc Skimmer	1			
Weir Skimmer	10			
Z14-E Rope Mop	10			
Barracuda Rope Mop	1			
MW 62 Rope Mop Skimmer	2			
Trans-Vac with Manta ray skimmers	2			
Acme Skimmer			2	

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION Deadhorse	Nome*	Dutch Harbor*	Anchorage
SOCK Skimmer			1	
Komara Miniskimmer			2	
Halliburton Fast Response Unit		1		
Halliburton Skimming Barrier w/mooring system		1	1	
Walosep Skimmer			1	
DISPOSAL				
Igniters	1,700			
Helitorch	1			
Dispersant	20 drums	10 drums	10 drums	160 drums
Fire Containment boom (2) in 2-40' storage vans	2,500'			
Helicopter Spray Unit				2
Ship Spray Unit				1
Hand Spray Unit			3	
Kewanee Boiler & Greer Separater Tank				1
Clean Fire Portable Incinerator				1

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION			
	Deadhorse	Nome*	Dutch Harbor*	Anchorage
Trecan Portable Incinerator (on loan from USCG)				1
Flaring Burner (on loan from USCG)				1
COLLECTANT				
Exxon OC5				5 drums
TRANSFER				
3/4" Arctic Suction Hose	25'			
2" Arctic Suction Hose	1,620'			
3" Arctic Suction Hose	4,020'	600'	600'	
3" Suction Hose			200'	
4" Suction Hose			200'	
3" Arctic Discharge Hose	2,000'	1,800'	1,000'	
3" Discharge Hose	•		400'	
4" Discharge Hose			400'	
Destroil Pump	1			
Briggs-Stratton Diaphragm Pump	10			
Warren Rupp Air Operated Diaphragm Pumps	3	3	3	

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION			
	Deadhorse	Nome*	Dutch Harbor*	Anchorage
Warren Rupp Air Operated Sludge Pump	3	3	3	
Barge Hatch Covers	9	3	3	
Wisconsin-Robin Trash Pump	10			
Gorman Rupp 4" pumps			4	
Hydraulic Power Pack			1	
Oil/Water Separaters 200 bbl			2	
Oil/Water Separaters 100 bbl			2	
STORAGE				
Firestone Fabritanks 2,250 gallons	20			
Firestone Fabritanks 4,400 gallons	4			
Firestone Fabritanks 25,000 gallons			2	
Trellecon Bladder	1			
Dracone Barges - 2,400 gals	4			
Dracone Barges - 2,500 gals			2	

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C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

	QUANTITY BY LOCATION			
Item	Deadhorse	Nome*	Dutch Harbor*	Anchorage
LOGISTICS - FACILITIES				
Portable Field Base Camp	1			
LOGISTICS - LIFE SUPPORT				
Herman Nelson Heaters 400,000 btu (in-direct fired)	3		1	
Tioga Heater 600,000 btu (in-direct fired)	1			
Life Support Boxes	20	1	1	
Response Boxes	20	1	1	
Weatherports - 7 1/2' x 8'	6			
Weatherports - 12' x 20'	7			
Homelite Generator - 1.5 kw	1			
Pincor B&S Generator - 3 kw	5			
Pincor B&S Generator - 5 kw	5			
Northern Lights Generator - 7.5 kw			1	
Pincor Lister Generator - - 8.5 kw	2			

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION Deadhorse	Nome*	Dutch Harbor*	Anchorage
Pincor Lister Generator - 13.5 kw	2	1		
Generator - 3 kw			2	
Tri-pod Flood lights	9 stands	1 stand	2 stand	1
Light plant	1			
Major First Aid Equipment	various	various	various	
MSA Air Packs	3	2	2	
Mustang Float Coats	60			
Imperial Survival Suits	60	15	10	
Stearns Life Vests	60		47	
LOGISTICS - VESSELS				
32' "North Star" Workboat	1			
21' Munson Workboat w/trlr Twin 70 hp outboard	1			
21' Munson Workboat Volvo V-8 outdrive	1			
19' Mark-V Zodiak Workboat w/50 hp mtr & trlr			1	

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION			
	Deadhorse	Nome*	Dutch Harbor*	Anchorage
19' Mark-V Zodiak Workboat w/85 hp mtr & trlr			1	
2-Man life raft			1	
Loran C Navigation				4
16' Grumman w/trlr 25 hp outboard	1			
15' Gregor w/trlrs 15 hp outboard	6			
18' Avon Searider		1	1	
90 hp Johnson outboards			2	
115 hp Johnson outboard			1	
LOGISTICS - SUPPORT				
Storage Shed - 6' x 12'	1			
Storage Shed - 10' x 10'	1			
Ford Heater - 100,000 but (Direct fired)	1			
Ford Heater - 150,000 btu (Direct fired)	9	2		
Ford Heater - 320,000 btu (Direct fired)	2			

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION Deadhorse	Nome*	Dutch Harbor*	Anchorage
Flatbed Trailer - 22'	1			
Flatbed Trailer - 18'	1			
Flatbed Trailer -40'			5	1
Flatbed Trailer			1	
Air Compressor			2	
Homelite Chainsaw - 36" bar	1			
Homelite Chainsaw - 24" bar	1			
Bird Rehabilitation Equipment	n/a			
Bird Scare-away Cannons	16	10	10	
Stihl Chainsaw - 36" bar	4			
Husquarna Chainsaw - 7' bar	1			
40' Storage Vans	2	2	2	1
20' Storage Vans	5	1	1	
LOGISTICS - VEHICLES				
International 18" Van Truck	1			
Kawasaki Snowmobile	2			

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION			
	Deadhorse	Nome*	Dutch Harbor*	Anchorage
Kawasaki ATV	1			
Chevrolet Crewcab	1			
Chevrolet S10 Blazer	1			
Ford 1 ton w/bed crane			1	
LOGISTICS - COMMUNICATIONS				
Command & Communications Modules/Vans	3	1	1	
Radio Telephone Lines	3			
Telephone Sets	8			
Marine VHF	1		1	
Contingency Network	1			
Logistics Network w/repeater and duplexer	1			
Operations Network w/repeater	1			
Compco Air - Ground	1			
10 Station PBX system			1	
UHF Mobile Radio Repeater		1	1	
Base Station UHF Antenna		1	1	

C-1 ALASKA CLEAN SEAS SPILL RESPONSE EQUIPMENT

Item	QUANTITY BY LOCATION Deadhorse	Nome*	Dutch Harbor*	Anchorage
Aviation Band - 720 channels			1	
SSB Base Station w/misc. ancillary equipment	1	1	1	
Motorola - UHF handheld w/extra batteries, headphones, battery chargers	20	6	6	
Motorola - VHF hand-held	5			
GE Hand carry Porta Mobil UHF & VHF	3			
General Electric Mastr II UHF & VHF	5			

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* The equipment designated for Nome and that for Dutch Harbor is all presently in long-term storage in Dutch Harbor. Reactivation of this equipment would take up to 2 weeks.

COOK INLET RESPONSE ORGANIZATION EQUIPMENT

SOURCES: Alaska Clean Seas Contingency Planning Manual, as revised, June 1985.
Exxon Beaufort Sea Oil-Spill-Contingency Plan, July 1986.

COOK INLET RESPONSE ORGANIZATION (C.I.R.O.) EQUIPMENT

ORGANIZATION:
Cook Inlet Response Organization (CIRO)

CONTACT PERSON:

Barry Eldridge, Manager
(907) 776-5129 (24 Hours)
(907) 283-7152 (Home)

Vicki Hudson
(907) 344-1191

CATEGORY: CONTAINMENT SYSTEMS

SUBCATEGORY:
Open ocean boom

o ITEM:
1 each - 1,450 Vikoma SeaPac containment boom

DESCRIPTION:
Inflatable containment boom housed in a 25' hull equipped with diesel-driven fan and water pump to simultaneously fill the air and water compartments of the boom.

SPECIFICATIONS:
Hull length: 25'
Hull width: 9'
System weight: 10,000 lbs
Boom weight: 3.165 lbs/ft
Floatation cuff: 3"
Free board: 27"
Draft: 17"

SUPPORT EQUIPMENT:
Workboat
Heavy duty trailer
Heavy duty highway vehicle

LIMITATIONS:
Waves over 6', winds greater than 25 knots.

LOCATION:
Kenai warehouse

SUBCATEGORY:
Nearshore/Harbor Boom

o ITEM:
1 each - 1,000' Aqua Fence containment boom

SPECIFICATIONS:
Free board: 18"
Draft: 18"
Weight: 8 lbs/ft

LOCATION:
Kenai pipeline yard

o ITEM:
1 each - 2,000' Ocean Dike compactable boom

DESCRIPTION:
Designed for containment and/or shoreline protection for nearshore waters or relatively calm open water.

900' in 75' sections on towable trailer.

550' in 50' sections on helo-pallets for air transport.

SPECIFICATIONS:
Free board: 10"
Draft: 16"
Ballast/tension member: 5/16" chain
Helo-pallet weight: 2,000 lbs each

SUPPORT EQUIPMENT:
- Workboats
- Packing frames
- Anchor/buoy systems
- Tow bridles
- Shore anchors

CATEGORY: RECOVERY SYSTEMS

SUBCATEGORY:
Vessel skimmers

o ITEM:
1 each - Lockheed 3100 Clean Sweep skimmer

DESCRIPTION:

The Lockheed 3100 is a self-propelled catamaran-type skimming vessel, designed for nearshore areas and bays, which has a revolving drum mounted between the pontoons. The drum itself has no moving internal parts; however, it is combined with oleophilic discs which are scraped clean by a static scraper blade.

SPECIFICATIONS:

Length:	27.1'
Width:	16.5'
Height:	15.5'
Draft:	2.3'
Weight:	25,000 lbs
Fuel storage capacity:	20 gallons (14 hours operation at full power)
Engine:	six-cylinder diesel (86 hp)
Propulsion:	2 hydraulic motor powered inboard/outboard drives
Steering:	hydraulic
Transit speed:	6 knots
Towing speed:	12 knots
Recovery speed:	0 - 1.5 knots
Recovered product storage:	200 gallons each hull

LIMITATIONS:

Can be dismantled into three parts in 3 to 4 hours for overland transport on two 30' flatbed trailers, or for air transport.

Works in waves up to 4'.

LOCATION:

Anchorage City Dock Freight Yard A

o ITEM:

1 each - Cyclonet 120 vortex skimmer

DESCRIPTION:

This vessel-mounted skimming device, which is designed for offshore oil recovery, may be deployed on the M/V Rig Engineer only. Installation time is approximately 4 hours. Unit is stored on lowboy storage/test trailer. The system includes:

2 - Cyclonets (120 cm diameter)
1 - 75 hp air cooled diesel engine
2 - variable displacement hydraulic pumps
2 - recuperators each equipped with a pollutant pump unit driven by a hydraulic motor and hydroejector
3 - 4" pollutant hoses each 33' long
2 - 2½" water hoses each 33 long

SUPPORT EQUIPMENT:

Vessel with storage tank
Tools
Fuel, oil, and hydraulic fluid
6 crew

LIMITATIONS:

Must be mounted on M/V Rig Engineer

LOCATION:

Rig Tenders Dock, Kenai

o ITEM:

1 each - Cyclonet 070 vortex skimmer

DESCRIPTION:

Vessel-mounted skimming device, mounted on a 31' x 18' diesel-powered vessel. This system includes:

2 - Cylonets (70 cm diameter)
2 - mountings complete
1 - Hatz 4.5 hp 3,000 rpm diesel pump
1 - Spate 3" pump rate delivery - 30 m^3/h
56 m of Cellofex hose of various diameters
1 - Hatz diesel-driven pump rate delivery 30 m^3/h at 6 bar for the ejectors, maximum suction head - 3 m W.G.

SPECIFICATIONS:

Total weight of equipment:	15,124 lbs
Transit speed:	8 knots
Fuel capacity:	80 gallons
Weight:	50,000 lbs (vessel and skimmer)

SUPPORT EQUIPMENT:

Vessels with low free board and storage tank
Tools
Fuel, oil, hydraulic fluid

LIMITATIONS:

Unit operates on large vessel, and is not transportable overland or by air.

LOCATION:

Rig Tenders Dock, Kenai

o ITEM:

1 each - Cyclonet 050 vortex skimmer

DESCRIPTION:

Vessel-mounted skimming device, designed for use in harbors and bays, mounted on 19' Zodiac MKV inflatable boat with a 50 hp Mercury outboard. This system includes:

2 - recuperators with 50 cm diameter hydrocyclones
Support frame
2 - hand-operated winches and support
Pumping unit - 4.5 hp, 3,000 rpm Peter diesel engine with starting device (pulley and cord or crank)
3" pump (130 gpm)
Trailer with 2" ball

SUPPORT EQUIPMENT:

1 rubber storage tank (130-gallon capacity)
6 lengths of 2" hose with quick couplings
Zodiac MKV inflatable boat with 50 hp Mercury outboard engine
Tools and towing line
1/2 to 3/4-ton vehicle to transport

LOCATION:

Kenai Pipeline Warehouse

****

SUBCATEGORY:

Portable Skimmers

o ITEM:

1 each - Komara Miniskimmer

DESCRIPTION:

This is an oleophilic disc skimmer designed for use on water under relatively calm sea conditions. The self-contained hydraulic system operates on a rotating disc principle and deals with all types of oil, even in the presence of debris.

SPECIFICATIONS:

Height:	18"
Width:	46"
Draft:	7.5"
32 rotating discs:	11.5" in diameter
Maximum recovery rate:	10 tons crude/hr
Skimmer box weight:	320 lbs

SUPPORT EQUIPMENT:

Hydraulic power source, hoses, floats, connectors
Hipboots for deployment from shore
Vessel for offshore deployment
Spare discs and lines
Storage container for recovered oil
Diesel fuel for prime mover

SPECIFICATIONS:

GPH capacity:	1,900
Total lift:	28'
Total head:	50'
Length:	29'
Width:	18"
Height:	21"
Weight:	77 lbs

LOCATION:

2 each - Kenai Pipeline Warehouse
1 each - Alaska Offshore, Inc. (Anchorage)

o ITEM:

1 each - Multiquip 3" centrifugal trash pump

****

SUBCATEGORY:

Power packs

o ITEM:

1 each - Komara Miniskimmer power pack

****

SUBCATEGORY:

Hoses

o ITEM:

1 each - 50' section of 3" arctic service suction
2 each - 50' section of 3" soft rubber petroleum discharge
2 each - 50' section of 2" suction
2 each - 50' section of 2" discharge

CATEGORY: STORAGE SYSTEMS

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o ITEM:

2 each - Uniroyal sealed tank

DESCRIPTION:

Collapsible neoprene storage tank with 3" kamlock fittings and triple interior integral lining.

SPECIFICATIONS:

Capacity:	4,570 gallons each @ 5 psi
Empty weight:	1,050 lbs
Flat dimensions:	39' x 7-1/4"
Fittings:	3"

LIMITATIONS:

Maximum wave height 2'; skimmer will handle some debris and emulsified oil.

LOCATION:

Kenai Pipeline Warehouse

o ITEM:

4 each - Rope Mop Machine 214-E

DESCRIPTION:

This light and portable skimming device is designed to recover a variety of oils in open water, with or without broken ice, and under solid ice. It wrings oil from oleophilic rope mops as they pass through two rollers. The oil is wrung into an open-topped 55-gallon drum. The mop length can be any adjusted.

SPECIFICATIONS:

Voltage:	115 volts
Mop size:	4" x 150'
Horsepower:	½ electric
Weight:	160 lbs

SUPPORT EQUIPMENT:

55-gallon drum (open top)
4" mop
2" diaphragm pump
3.5 kw generator
Tail pulley
2" hose

LOCATION:

2 each - Kenai Pipeline Warehouse
2 each - Alaska Offshore, Inc. (Anchorage)

CATEGORY: TRANSFER SYSTEMS

SUBCATEGORY:

Pumps

o ITEM:

2" diaphragm pumps

DESCRIPTION:

Pumps are Homelite Model 111DP2-1, fitted with 2" kamlocks, powered by Briggs & Stratton 3 hp gasoline engines.

SUPPORT EQUIPMENT:

- Forklift for moving crate
- Dikes, impermeable liners
- Fire protection equipment
- Adapters, kamlock fittings
- Pumps and hoses (2/tank)
- Strapping system

LIMITATIONS:

Maximum capacity:	4,750 gallons
Maximum tank height:	44" (full)
Air temperature range:	40°F to 160°F
Onshore site:	maximum 3' rise/100'

LOCATION:

Kenai Pipeline Warehouse

CATEGORY: VESSELS

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o ITEM:

2 each - Pioneer polyethylene workboat

DESCRIPTION:

Modified to accept bird scare-away devices which may be mounted in boats.

SPECIFICATIONS:

Weight:	75 lbs
Length:	95"
Boom:	48"
Depth:	17"
Capacity:	345 lbs
HP range:	2 hp

SUPPORT EQUIPMENT:

- Oars or paddles
- Lifejackets
- Outboard
- Gasoline and gasoline container
- Line
- Fire extinguisher

LOCATION:

Kenai Pipeline Warehouse

o ITEM:

1 each - Zodiac Mark V

DESCRIPTION:

Inflatable workboat with Cyclonet 050 system on trailer with 2" ball.

SPECIFICATIONS:

Length:	19'
Beam:	7' 9"
Weight:	530 lbs
Engine:	Mercury outboard @ 50 hp

SUPPORT EQUIPMENT:

1/2 to 3/4-ton vehicle to tow
Fuel
Lines, paddles, lifejackets, air pump and patch kit

LIMITATIONS:

Maximum Payload:	3,300 lbs
Maximum Passenger Capacity:	15

LOCATION:

Kenai Pipeline Warehouse

- o ITEM:
  1 each - M/V Rig Engineer

DESCRIPTION:

The Rig supply vessel, under charter to Marathon Oil, is modified for mounting the Cyclonet 120 skimmer system. In order for this vessel to be used, a release must be obtained from Marathon and the cost of charter or relief vessel reimbursed. Contact (907) 274-1511.

CATEGORY: SORBENTS

- o ITEM:
  7 bales - 3M Type 280 sorbent boom

DESCRIPTION:

4 double booms/bale
4.5" x 4.5" x 10'

LOCATION:

CIRO 20' Response Trailer
Kenai Pipeline Wareshouse

- o ITEM:
  2 boxes - PomPom's

LOCATION:

CIRO 20' Response Trailer
Kenai Pipeline Warehouse

CATEGORY: OIL SPILL CHEMICALS/APPLICATORS

SUBCATEGORY:
Chemicals

- ITEM:
1 each - Exxon OC-5 collectant (55-gallon drum)

LOCATION:
ARCO Yard (Kenai)

- ITEM:
90 each - Exxon COREXIT 9527 dispersant (55-gallon drum)

LOCATION:
ARCO Warehouse (North Kenai)

- ITEM:
5,000 gallons dispersant (in tank trailer)

LOCATION:
Kenai

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SUBCATEGORY:
Applicators

- ITEM:
2 each - Simplex helicopter aerial spray unit

DESCRIPTION:
Helicopter sling spray system for application of oil spill chemicals. The system includes:

Simplex Model 2200 wet bucket and packet
Simplex Model 934 4' boom extensions
Simplex Model 2660 bucket dolly
Adjustable application rates

SPECIFICATIONS:

Boom span:	32'
Weight spray bucket:	320 lbs/empty
Flow:	100 gpm/maximum
Power source:	Homelite 8 hp gas engine
Bucket capacity:	300 gallons
Spray swath width:	40'

SUPPORT EQUIPMENT:
Helicopter with cargo hook
Dispersant filling system from tank truck

LIMITATIONS:

Maximum bucket capacity 300 gallons, and helicopter lifting capacity 3 tons (minimum).

LOCATION:

Kenai Pipeline Warehouse

CATEGORY: BIRD/MAMMAL PROTECTION

- ITEM:

  15 each - "Scare-Away" Model M-4 cannon

DESCRIPTION:

Cannon fired by liquefied petroleum gas to keep birds and mammals away from oil contaminated areas.

SPECIFICATIONS:

Steel construction
Electronic ignition of LPG
Sound similar to 37-mm cannon
Variable detonation frequency
2 scare-away devices modified for installation on 8' Pioneer workboats

SUPPORT EQUIPMENT:

LPG supply
8' Pioneer workboat

LIMITATIONS:

Must be turned on once per day; birds and mammals may become accustomed to the sound after exposure to the sound over a long period of time.

LOCATION:

Kenai Pipeline Warehouse

- ITEM:

  1 each - oiled-bird survival kit

LOCATION:

CIRO 20' response trailer
Kenai Pipeline Warehouse

CATEGORY: VEHICLES

- ITEM:

  1 each - Ford 3/4-ton van

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DESCRIPTION:
Vehicle is equipped with towbar, one 1-7/8" ball and one 2" ball.

o ITEM:
1 each - Mini-Max all-terrain vehicle

DESCRIPTION:
This amphibious vehicle, which can be used for beach patrol, is equipped with a 2" ball hitch. The transport trailer may be attached to the rubber tired ATV for use with the beach cleanup package.

LOCATION:
Kenai Pipeline Warehouse

o ITEM:
1 each - Kawasaki all-terrain cycle

DESCRIPTION:
Three-wheeled motorcycle equipped with 2" ball hitch. Transport trailer may be towed behind ATC.

LOCATION:
Kenai Pipeline Warehouse

o ITEM:
1 each - 20' response trailer

DESCRIPTION:
Designed for initial response as well as field office. Equipped with 2" ball for towing by 3/4-ton vehicle. Equipment found in the trailer includes:

280' 3M Type 280 sorbent pads
7.5 kw Homelite generator
Beach cleanup tools
Bird survival kit
VHF base station

LOCATION:
Kenai Pipeline Warehouse

CATEGORY: COMMUNICATIONS

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o ITEM:
1 each - VHF base station

DESCRIPTION:
Channels 6, 10, 11, 16, 22A, 81A

LOCATION:
CIRO Response Trailer
Kenai Pipeline Warehouse

o ITEM:
8 each - VHF portable radio

DESCRIPTION:
Channels 6, 10, 11, 16, 22A, 81A

LOCATION:
Kenai Pipeline Warehouse

o ITEM:
1 each - portable telephone

DESCRIPTION:
Range: 1,000'

LOCATION:
Kenai Pipeline Warehouse

o ITEM:
1 each - citizen band radio

DESCRIPTION:
40-channel with external antenna

LOCATION:
CIRO response van

CATEGORY: MISCELLANEOUS EQUIPMENT

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o ITEM:
2 each - Homelight 7.5 kw generator
4 each - barrel-mounted sorbent wringer
3 each - anchor/buoy system
3 each - boom lights for Ocean Dike Containment Boom
1 each - steam cleaner system
1 each - Lincoln portable welder
1 each - oxy-acetylene cutting torch
1 each - tool set
1 each - JVC portable video cassette recorder/VHS format 110 volts, 12 volts, or battery
1 each - 14" color tv
1 each - 35 mm Pentax SLR camera
1 each - 35 mm slide projector with screen
1 each - JVC color video camera

UPDATED LIST OF
ADDITIONAL CIRO RESPONSE EQUIPMENT(1)

July, 1986

QUANTITY	ITEM
	Containment
1000 ft.	Expandi boom 3000 on power reel system
1000 ft.	Kepner boom (6" freeboard, 8" skirt)
	Recovery
1	ODI vessel of opportunity skimmer
2	Manta ray skimmers
	Vessels
1	34 ft. fiberglass hull Raider
1	18 ft. inflatable Hurricane (rigid hull) with 70 hp Johnson motor
	Storage
2	4000 gallon towable floating bladders
	Dispersing Systems
1	Frank Ayles spray system (2-35 ft. booms) for supply vessel of opportunity
1	Slickbar, Inc. spray system (2-20 ft. booms) for the Raider
	Support Equipment
3	3 inch Diaphram diesel pumps
1	40 ft. flatbed trailer for ODI skimmer
1	GMC 4-wheel drive crew cab pickup

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(1) Equipment is located in Kenai except for 500 ft. of the Kepner boom which is located in Anchorage.

asi - ALASKA EQUIPMENT

SOURCE: asi - Alaska, December 1986.

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asi - ALASKA

ASI is currently purchasing the warehouse/office complex we are operating out of. Adjacent to the 3,900' warehouse, we have a 19,000' secured yard.

	Location	
	CA Office	AK Office
CONTAINMENT SYSTEMS:		
Boom Expandi 7000	750'	-
Boom Expandi 4300	12,300'	6750 '
Boom Expandi 3000	2,050'	50 '
Boom Expandi 2000	2,000'	-
Towing Adapter 4300	20/ ea.	6/ ea.
Sea Anchors (Draugs)	20/ ea.	6/ ea.
Sea Anchor Systems	6/ ea.	8/ ea.
Reel	6/ ea.	1/ ea.
Roto Pak	6/ ea.	1/ ea.
Power Pak w/Dispersant Pump	10/ ea.	2/ ea.
Buoys	50/ ea.	24/ ea.
EnviroGuard (Drummed)	200/ ea.	90/ ea.
EnviroGuard Bins (50 22lb Bags/ea.)	100/ ea.	35/ ea.
RECOVERY SYSTEMS:		
Walosep W-M Skimmer with Power Pak	2/ ea.	-
Walosep W-1 Skimmer with Power Pak	7/ ea.	2/ ea.
Walosep W-2 Skimmer with Power Pak	2/ ea.	-
Walosep W-3 Skimmer with Power Pak	1/ ea.	-
Walosep W-4 Skimmer with Power Pak	1/ ea.	-
Rope Mop Skimmer	2/ ea.	-
Acme Skimmer	1/ ea.	-
Komara Mini Skimmer	-	2/ ea.
Tobex 90 Beach Cleaner	1/ ea.	-
Tobex 900 Beach Cleaner	1/ ea.	2/ ea.
600 Gallon Oil Water Seperating Tank	-	1/ ea.
800 Gallon Oil Water Seperating Tank	-	1/ ea.
1200 Gallon Oil Water Seperating Tank	2/ ea.	-
1500 Gallon Oil Water Seperating Tank	6/ ea.	-
4000 Gallon Oil Water Seperating Tank	1/ ea.	-
Crane (2 to 4 ton)	6/ ea.	1/ ea.
Mop Wringer	2/ ea.	2/ ea.
Mop	200 '	200 '
500 Gallon Towable Sea Bladder	-	1/ ea.
1000 Gallon Towable Sea Bladder	3/ ea.	-

TRUCKS:

4 Wheel Drive Crew Cabs	2/ ea.	2/ ea.
Crew Cab	1/ ea.	1/ ea.
Stake Trucks	2/ ea.	-
5 Ton Crane Truck	1/ ea.	-

BOATS:

18' Aluminum Bayrunner Boat (115 hp)	7/ ea.	1/ ea.
18' RHI's (70 hp)	3/ ea.	-
21' Boat (230 hp)	1/ ea.	-
50' Boat	1/ ea.	-
115 Mercury Outboard Engine	-	1/ ea.

MISCELLANEOUS SUPPORT EQUIPMENT:

Sorbents (Sheets, Rolls)	1,100 bxs.	400bxs.
Response Trailers (Each w/ WoodCaddy, Sorbents, Boom, Safety Gear, Mop Machine, Hand Tools, and A WarmUp / Office Room)	1/ ea.	2/ ea.
Equipment Trailers	2/ ea.	-
Mobile Command Unit	1/ ea.	-
Boom Washers	2/ ea.	-
400 Gallon Oil Storage Bags	40/ ea.	-
500 Gallon Oil Storage Bags	-	50/ ea.
Boom Repair Kit	1/ ea.	1/ ea.
Hand Tools	Misc.	Misc.
LifeAir 10 min. Emergency Escape Breathing Systems	-	4/ ea.
Burges Sprayer 3 1/2 Gallon	-	1/ ea.
3" Discharge Hose	Misc.	Misc.
2" Suction Hose	Misc.	1000'
3" Suction Hose	Misc.	700'
WoodCaddy w/Accessories	6/ ea.	6/ ea.
Drums OC-5 Dispersant	6/ ea.	6/ ea.
3" Barb Camlocks / Male and Female	3/ ea.	3/ ea.
50' Welding Leds	2/ ea.	2/ ea.
5' Spray Bar Extensions w/camlocks	18/ea.	18/ea.
Plastic Fuel Tanks	2/ ea.	2/ ea.
35' Hydraulic Hose	2/ ea.	2/ ea.
Rain Suits, Rubber Boots, Face Shields, Survival Suits, Gloves	Misc.	Misc.

CROWLEY ENVIRONMENTAL SERVICES EQUIPMENT (ALASKA)

SOURCE: ARCO Alaska, Inc., Sale 70, Oil-Spill-Contingency Plan, April 1984.

OFFSITE OIL SPILL CONTAINMENT, CLEANUP AND DISPERSANT EQUIPMENT: PRIVATE CONTRACTORS*

1. CROWLEY ENVIRONMENTAL SERVICES (CES)

CONTACT PERSON:	Mr. Chuck Watkins
TELEPHONE NUMBER:	(907) 344-1511 (24-hour)

CATEGORY: CONTAINMENT SYSTEMS

SUBCATEGORY:
Open Ocean Boom

ITEM:

1 each - 1,000' Whittaker Model 4300 Expandi Boom (boom is palletized and includes all accessories)

1 each - 500' Kepner Sea Curtain Compactible Boom (14" x 6")

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SUBCATEGORY:
Harbor/Shoreline Boom

ITEM:

1 each - 2,100' Kepner Sea Curtain Standard Boom (8" x 12")
1 each - 900' Kepner Sea Curtain Standard Boom (8" x 12")
1 each - 500' Kepner Sea Curtain Standard Boom (6" x 12")

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SUBCATEGORY:
River/Stream Boom

ITEM:

1 each - 700' Kepner Sea Curtain Fastwater Compactible Boom (8" x 12")

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* Inventory subject to change; response personnel are located in Seattle.

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CES (cont.)

CATEGORY: RECOVERY SYSTEMS/SEPARATORS

ITEM:

Oil Mop Oil/Water Separator
3 each - CES Oleo III Skimmer
CES SLURP Skimmer
Lockheed Disc Skimmer
4 each - Vac-U-Max Open Top Skimmer
Gardner-Denver Portable Air Compressor
Oil Mop MK II-4H (hydraulic)
Oil Mop MK I-4E (electric)
Oil Mop Accessories: 300' OCW 4-6 rope mop, 100' OCW 3-4 rope mop, 3 TP-16 pullies, 3 TP-12 pullies, 280' 4" rope, 100' 6" rope
Slickbar 36" Manta Rigid Skimmer
Slickbar 48" Manta Flexible Skimmer
2 each - Oil Recovery System Scavengers

CATEGORY: TRANSFER SYSTEMS

SUBCATEGORY:

Pumps (all pumps are explosion-proof and kamlocked)

ITEM:

Homelite 2" Diaphragm - 30 gpm
2 each - Stanley 2-1/2" Submersible - 500 gpm (hydraulic power pack required)
Homelite 1-1/2" Centrifugal - 150 gpm
2 each - Homelite 2" Trash - 195 gpm
Homelite 1-1/2" High Pressure
Homelite 4" Trash - 610 gpm (electric start)
3 each - Homelite 3" Centrifugal - 300 gpm
Homelite 3" Trash - 385 gpm
Gorman Rupp 3" Lister Diesel Trash - 320 gpm (electric start)
Multiquip 3" Trash - 30 gpm
2 each - Edson 2" Hand Diaphragm
Wilden 3" Double Diaphragm (air driven)
2 each - Homelite 3" Diaphragm

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SUBCATEGORY:

Hose

CES (cont.)

ITEM:

12 each - Suction - 2" x 20'
6 each - Discharge - 2" x 50'
22 each - Suction - 3" x 20'
20 each - Discharge - 2" x 50'
17 each - Suction - 4" x 20'
7 each - Discharge - 4" x 50'
4 each - Fire Hose - 1-1/2" x 50'
4 each - Hydraulic - 50' x 1-1/2"
4 each - Hydraulic - 50' x 3/4"
9 each - Suction - 4" x 24'
1 each - Suction - 3' x 20' (light weight)

CATEGORY: STORAGE

ITEM:

All tanks are complete and boxed for shipment.

Kepner 300-gallon pillow tank
2 each - Kepner 600-gallon towable
Goodyear 1,000-gallon bladder tank
3 each - Uniroyal 10,000-gallon bladder tank
Goodyear 10,000-gallon bladder tank
2 each - Uniroyal 20,000-gallon bladder tank
3 each - Uniroyal 500-gallon sealed drum
Skid-Mounted 300-gallon steel tank
Geer 10,000-gallon steel tank

CATEGORY: TRANSPORTATION

SUBCATEGORY:

Vessels

ITEM:

CES, as a subsidiary of CMC, can provide numerous larger vessels.

17' Boston Whaler with 70 hp Johnson Outboard
21' Munson aluminum workboat with 70 hp Johnson outboard
Zodiac MK IIIGR
Zodiac MK IVGR
2 each - 10' Pioneer workboats

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SUBCATEGORY:
Outboards

ITEM:
1977 Johnson - 9.9 hp
1980 Johnson - 9.9 hp
1979 Evinrude - 9.9 hp
1979 Suzuki - 20.0 hp
1977 Johnson - 25.0 hp
1977 Evinrude - 35.0 hp
1980 Johnson - 70.0 hp

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SUBCATEGORY:
Vehicles

ITEM:
1963 Kenworth 65-bbl vacuum truck
1977 International 5-Ton flatbed truck with National crane
1975 Kenworth truck/tractor with winch
1960 Autocar diesel boom truck
1973 GMC 1-1/2" ton van truck
1979 Chevrolet 3/4-ton 4 x 4 pickup
1980 Ford Courier light duty pickup
1982 Datsun 1/2-ton 4 x 4 pickup
1980 Oldsmobile stationwagon
1969 Michigan front loader
Caterpillar 2-ton forklift
Clark 2-ton forklift
1964 Downs 40' lowboy
1974 utility 40' van semi-trailer (response van)
1974 utility 40' van semi-trailer
7 each - 20' cargo van
3 each - 24' cargo van
5 each - 12' cargo van
1978 25' trailer for boston whaler
E-Z Load 25' trailer for munson

CATEGORY: COMMUNICATIONS EQUIPMENT

ITEM:
7 each - Motorola UHF MX 360 Portable

DESCRIPTION:
Complete with charger, carrying case, antennas, remote mikes, and one boom mike headset. All portables transmit on 459 MHz, and receive on 454 MHz. This system includes:

CES (cont.)

10 each - Motorola battery
UHF base station (25-watt)
MILCOR UHF Repeater (Mt. Susitna)
4 each - Converta-Con UHF console with accessories
3 each - MCCOM-70 UHF vehicle unit
Portable communications shack
Motorola DVP portable repeater
4 each - Modar/Triton VHF portable (channels 6, 16, 10, 81)
4 each - standard 831 VHF portable (channels 6, 16, 10, 11, 22, 81)

All VHF portables include batteries, chargers, carrying cases, and remote mikes.

Modar/Triton 55/75 VHF portable base
2 each - Modar 10-Channel VHF base
Newmar Convertex (120/12-volt)
Regency VHF scanner
DECCA SSB 150/SSB base
3 each - standard battery
Motorola/JVC Series Radio Pagers
  8 Spirit pagers with chargers
  2 Minitor pagers with chargers
  2 Encoders

CATEGORY: SORBENTS

ITEM:

CES maintains a minimum of $350,000 inventory of 3M sorbent products at all times.

Standard Oil Sorbents

3M Type 100 rolls	36" x 150' x 3/8"	
3M Type 126 sweeps	19" x 100' x 3/8"	
3M Type 151 pads	18" x 18" x 3/16"	200 sheets/bale
3M Type 156 pads	18" x 18" x 3/8"	100 sheets/bale
3M Type 157 pads	36" x 36" x 3/8"	50 sheets/bale
3M Type 240 pillows	5" x 14" x 25"	10 pillows/bale
3M Type 270 boom	8" dia. x 10'	4 booms/bale
3M Type 280 boom	Four 10' double booms/bale	

Anti-Static Sorbents

3M Type 500 rolls	36" x 150' x 3/8"	
3M Type 551 pads	18" x 18" x 3/16"	50 sheets/bale
3M Type 556 pads	18" x 18" x 3/8"	25 sheets/bale
3M Type 557 pads	36" x 36" x 3/8"	25 sheets/bale

CES (cont.)

Liquid Sorbent Material (LSM)

3M Type R-12 - 12" x 100" x 1/8" - 4 rolls/case
3M Type R-18 - 18" x 100" x 1/8" - 2 rolls/case
3M Type R-3L - 36" x 100" x 1/8" - 1 roll/case
3M Type S-12 - 12" x 12" x 1/8" - 50 sheets/bag-
8 bags/box

Viscous Oil Sorbent (limited to stock on hand)

3M Type 356-S - 25 pieces/box
3M Type 356-C - 100 pieces/box

INSORB Industrial Towel Wipes

3M Type 9772 - 12" x 13"/white - 480 sheets/box
3M Type 9782 - 12" x 13"/gray - 480 sheets/box

CATEGORY: MISCELLANEOUS EQUIPMENT

ITEM:

MSA explosion meter
3 each - MSA portable air pack
2 each - Homelite chainsaw
2 each - Stihl chainsaw
2 each - Homelite gas generator 2.75 kw
2 each - Homelite gas generator 7.5 kw
Stanley gasoline hydraulic system (includes 2-10-gpm systems @ 2,000 psi)
Faryman diesel hydraulic system power pack
3 each - Homelite electric-driven 100,000 btu heaters
2 each - Propane 420,000 btu heaters (1 with bottle)
Hotsey pressure washer
Ventilating fan 24" (explosion-proof)
Gastech 0^2 explosion meter
Tac H_2S meter
Homelite cut-off saw
Lincoln arc welder (200 amp portable)
Lincoln Tig arc welder
Melben shop compressor
Essick compressor
Craftsman table saw
2 each - Victory Oxy/Acetylene Set
Craftsman set shop mechanic tools
Craftsman bench grinder
Kleer-Flo parts washer
Solar battery charger
Associated battery charger

CES (cont.)

Chatillon tensiometer
Portable light stands
4 each - Explosion-proof light systems
2 each - East Wind chemical protective suits
MSA supplied air breathing systems

CATEGORY: EQUIPMENT LEASE PACKAGE

ITEM:
12' x 8' x 8' cargo van (total weight - 4,000 lbs)

DESCRIPTION:

- Recovery Systems
  - Oleophilic rope mop with tail pulley and 100' of mop and recovery barrel
  - Manta Ray skimmerhead with 3" male kamlock

- Pumps
  - 3" electric diaphragm pump with explosion-proof motor
  - 3" trash pump with explosion proof motor

- Hose
  - 4 each - 50' sections of 3" suction hose
  - 3 each - 100' sections of 3" discharge hose

- Storage
  - 5,000-gallon bladder with supported liner

- Miscellaneous Support Equipment
  - 2 each - Portable 500-watt adjustable lightstands
  - Waterproof cord reel with 150' electric cord
  - Homelite 3.5 kw generator
  - Field repair kit with necessary tools and spares
  - Kamlock adaptor box with assorted fittings
  - 1 roll 1/4" wire mesh diking material
  - 5 bales 3M Type 157 pads
  - 5 rolls 3M Type 100 rolls
  - 1 bale 3M Type 270 boom
  - 1 roll 6-ml visqueen
  - 1 spool 1/4" manila line
  - 1 spool 3/8" poly line
  - Heavy duty plastic bags
  - Rakes, shovels, pitchforks

CATEGORY: PRUDHOE BAY RESPONSE PACKAGE

TELEPHONE:
(907) 659-2326
(907) 344-1511 (24-hour)

ITEM:
2 each - 20-foot container van

DESCRIPTION

. Containment System
- 1 each - 1,000' Kepner Sea Curtain Standard Boom - 8" x 12"
- 2 each - tow plate
- 2 each - tow bridle
- 1 each - complete boom repair kit
- 1 each - anchor/buoy kit (includes five 70-pound anchor/buoy systems)

. Recovery Systems
- 1 each - Slickbar 3" Manta Ray with 36" suction head
- 1 each - Oil Recovery Systems MKII4-E Oil Mop Machine

(Includes 100' rope mop; 2 each - tail pulleys; 5 kw Multiquip generator; and additional required accessories)

. Transfer Systems
- Pumps
  1 each - Multiquip 3" diaphragm
  1 each - Multiquip trash (diesel)
  1 each - Tokheim hand-operated diaphragm

- Hose
  3 each - suction 3" x 20'
  3 each - discharge 3" x 50'

. Storage Systems
(all bladders complete with 3" kamlocks, valves, liners and boxed for shipment)
- 1 each - 5,000-gallon collapsible berm
- 1 each - 5,000-gallon bladder

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CES (cont.)

- Sorbents
  Availability of 3M sorbents will vary. Call (907) 659-2326 or 344-1511 for specific availability.

Standard Oil Sorbents

3M Type 100 rolls	36" x 150' x 3/8"	
3M Type 126 sweeps	19" x 100' x 3/8"	
3M Type 151 pads	18" x 18" x 3/16"	200 sheets/bale
3M Type 156 pads	18" x 18" x 3/8"	100 sheets/bale
3M Type 157 pads	36" x 36" x 3/8"	50 sheets/bale
3M Type 240 pillows	5" x 14" x 25"	10 pillows/bale
3M Type 270 boom	8" dia. x 10'	4 booms/bale
3M Type 280 boom	Four 10' double booms/bale	

Anti-Static Sorbents

3M Type 500 rolls	36" x 150' x 3/8"	
3M Type 551 pads	18" x 18" x 3/16"	50 sheets/bale
3M Type 556 pads	18" x 18" x 3/8"	25 sheets/bale
3M Type 557 Pads	36" x 36" x 3/8"	25 sheets/bale

INSORB Industrial Towel Wipes

3M Type 9772	12" x 13"/white	480 sheets/box
3M Type 9782	12" x 13"/gray	480 sheets/box

- Vehicles
  - 2 each - 1980 Chevrolet 1/2-ton pickup
  - 1 each - 1960 Ohio 40' semi-trailer - sorbent storage
  - 1 each - 1980 Yamaha T25CC tri-moto 3-wheeler all terrain vehicle

- Miscellaneous Equipment
  - 1 each - 20' heated shop van (completely equipped with hand-tools, fittings, rigging, personnel support gear, small engine repair kits and spare parts)
  - 1 each - Multiquip 5-kw generator
  - 1 each - Kamlock adaptor kit
  - 1 each - box of plastic bags
  - 1 each - roll of plastic sheeting
  - 1 each - Modar model #D23AL820 radio
  - 3 each - 20' bonding cable

UNITED STATES COAST GUARD EQUIPMENT (ALASKA)

SOURCE: U.S. Coast Guard Marine Safety Office, Anchorage, July 1985.

I 72.12/3:OF 2/3 .

OIL-SPILL-RESPONSE MEASURES FOR
OFFSHORE OIL AND GAS OPERATIONS...
UNITED STATES DEPARTMENT OF THE
INTERIOR... APRIL 1987

3 OF 3
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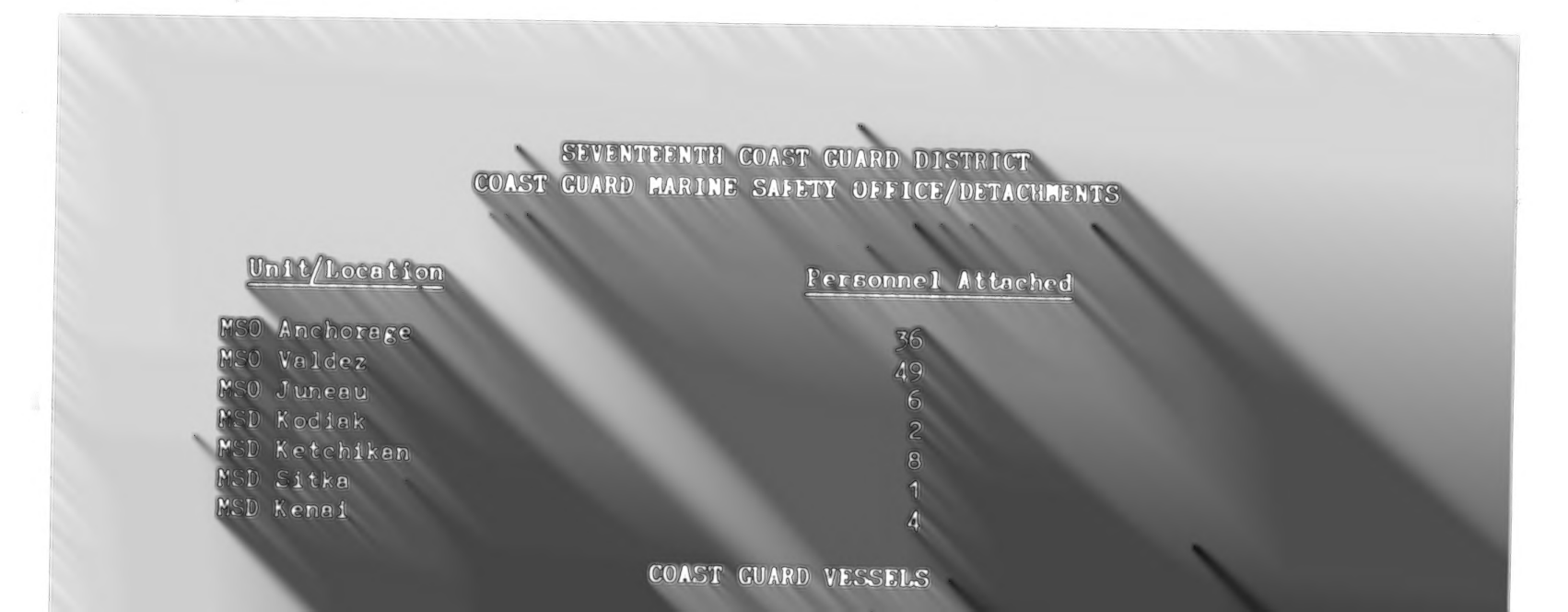
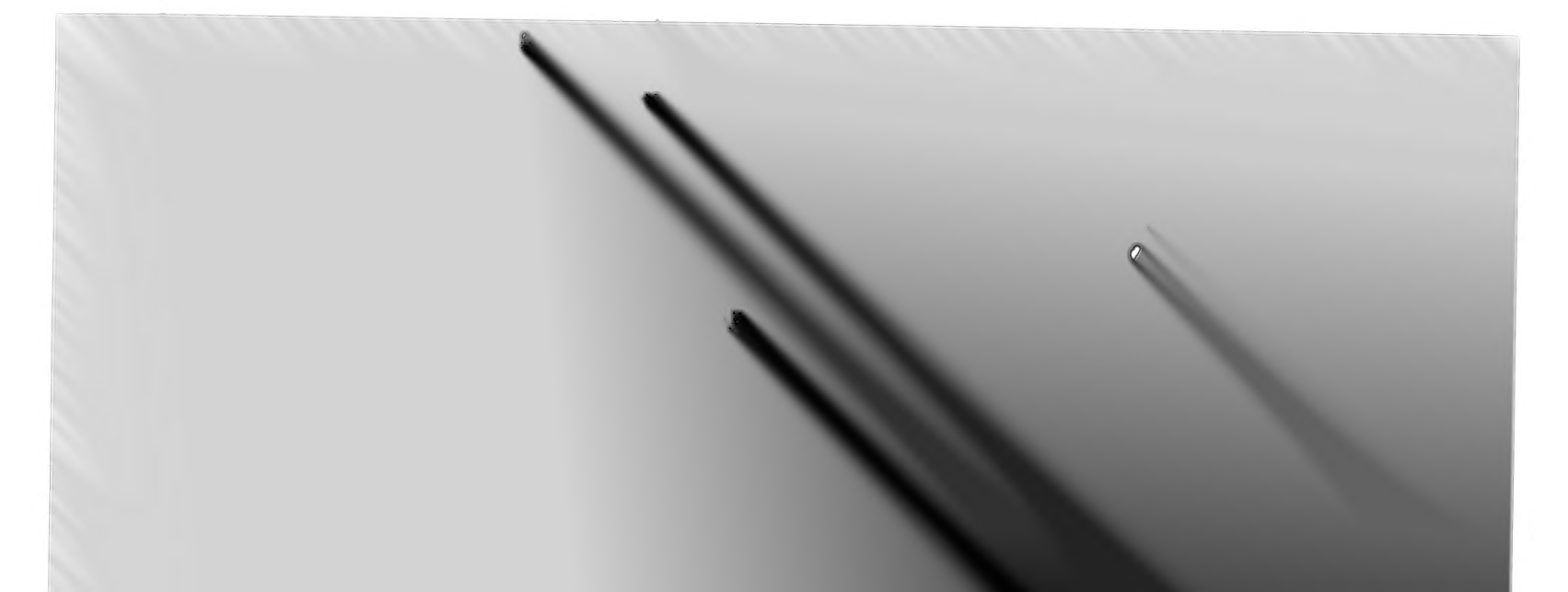
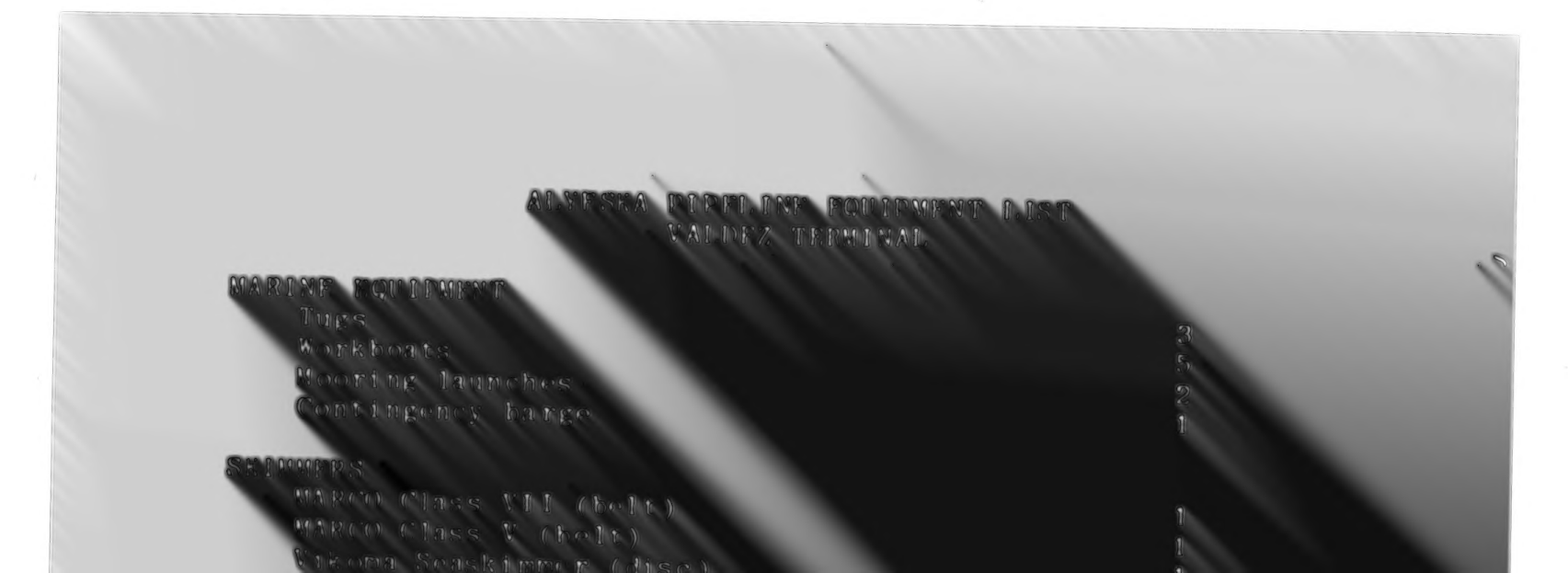
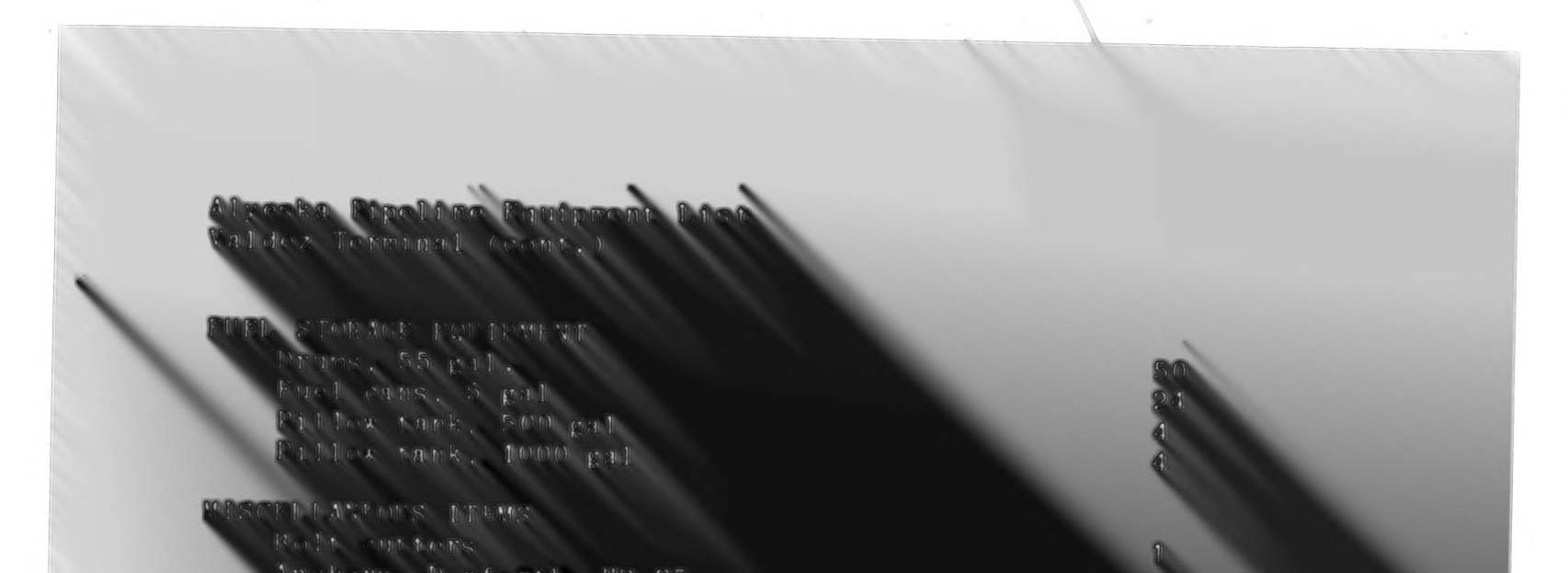
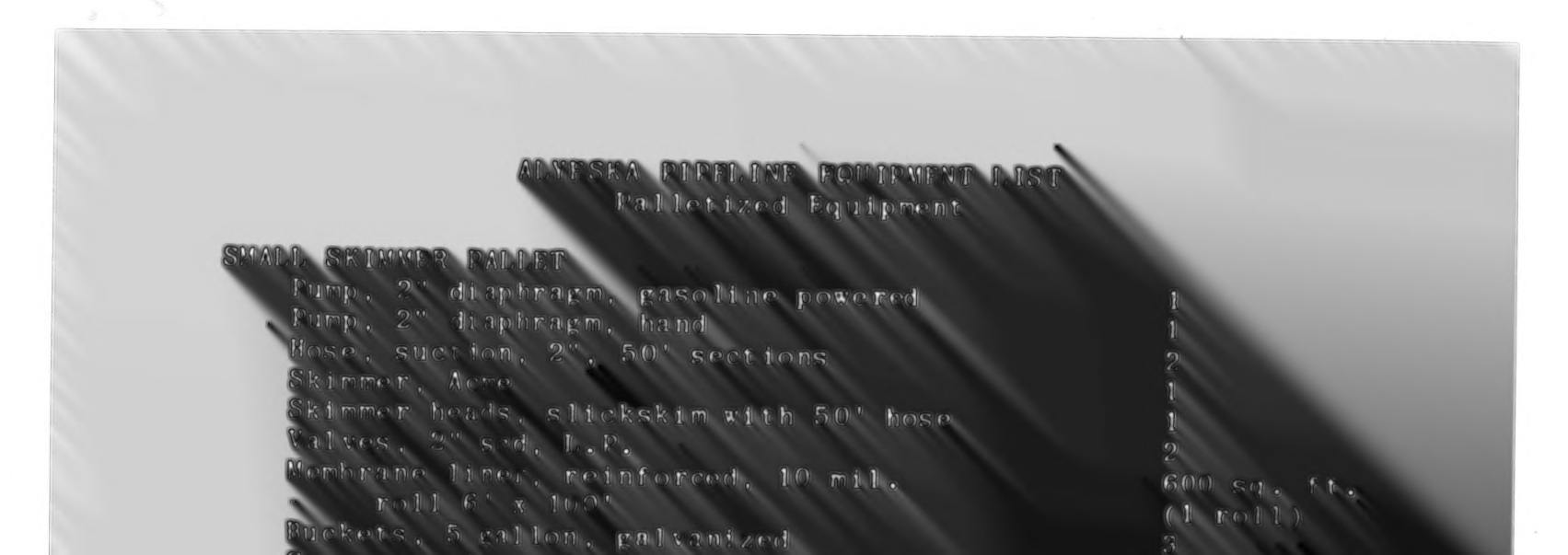
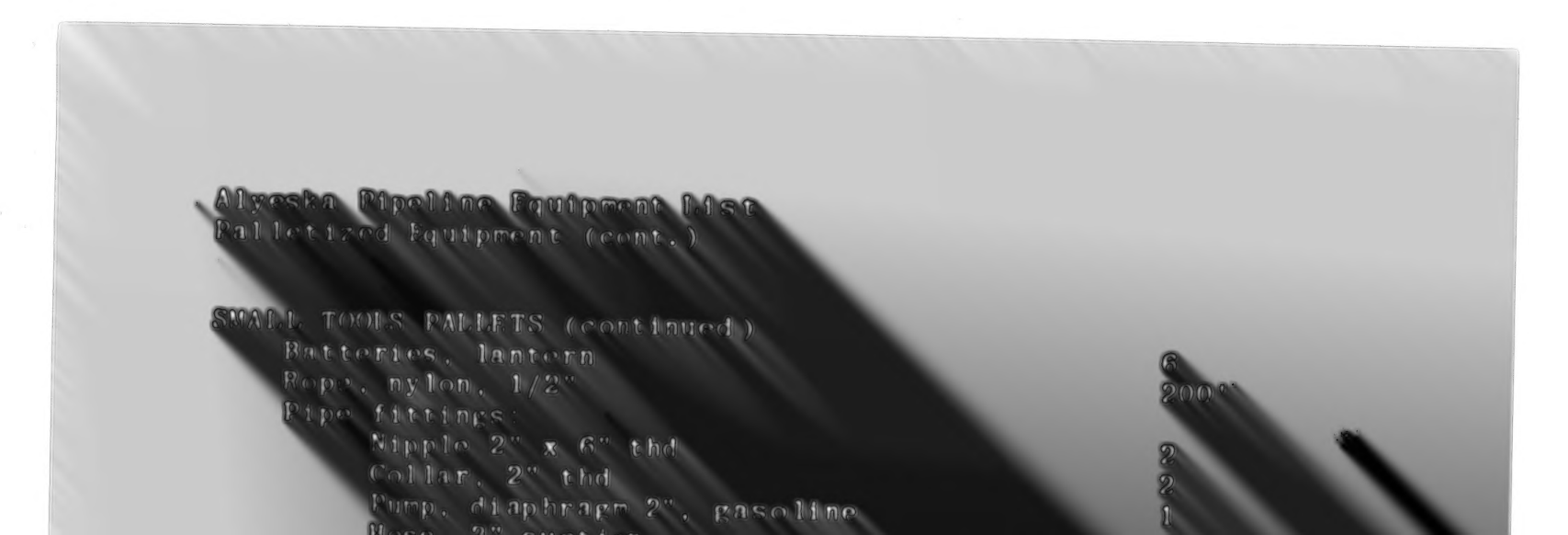
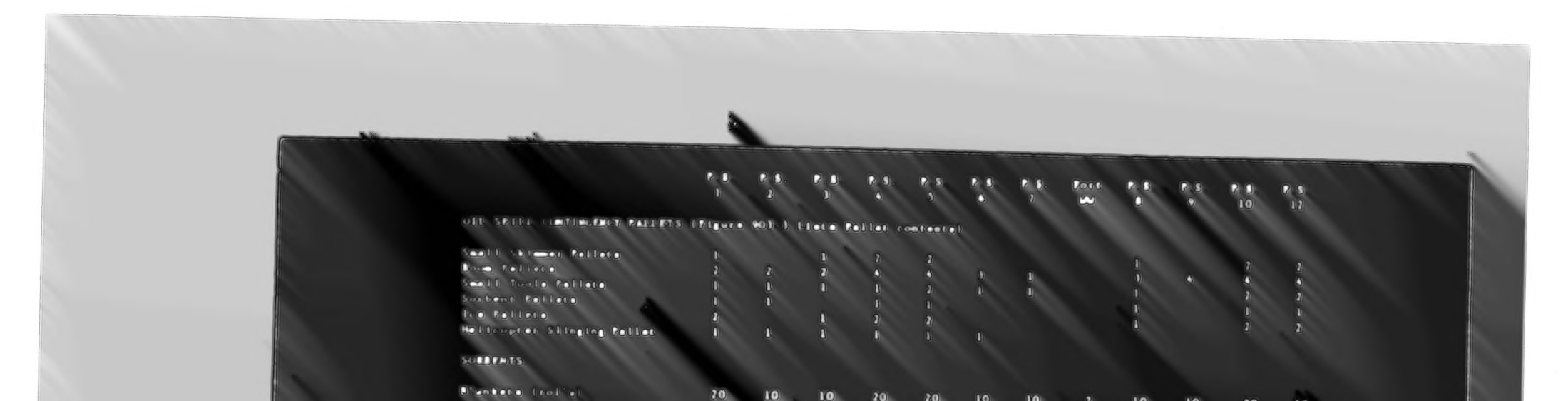
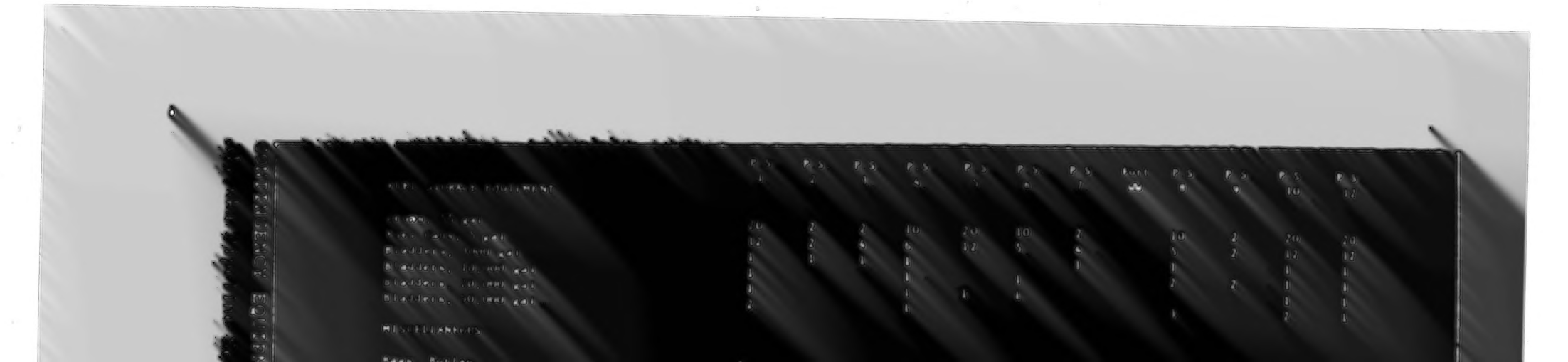
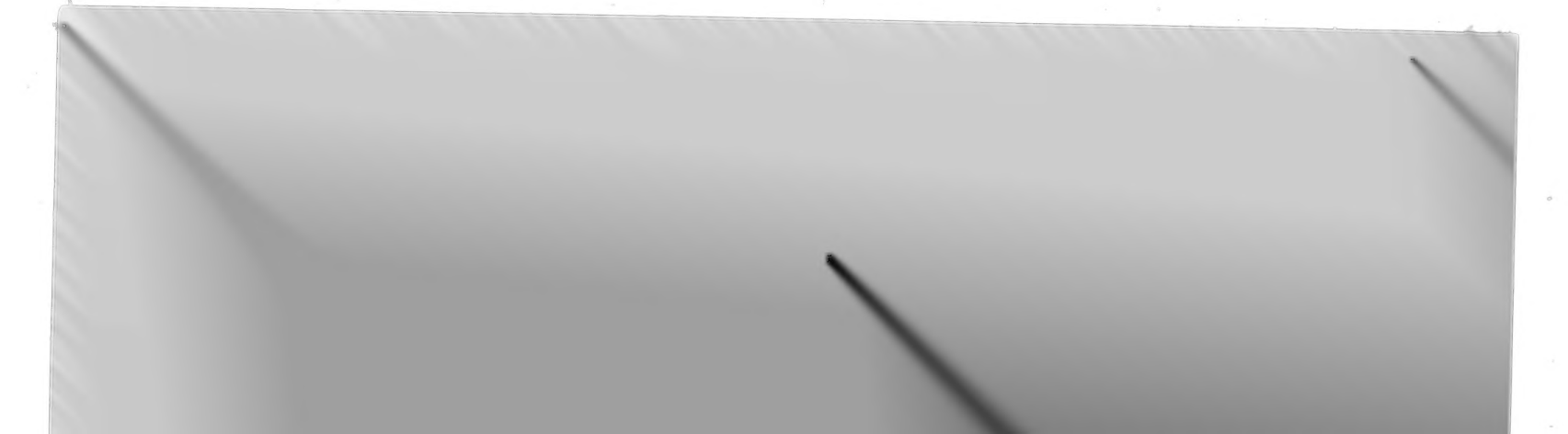
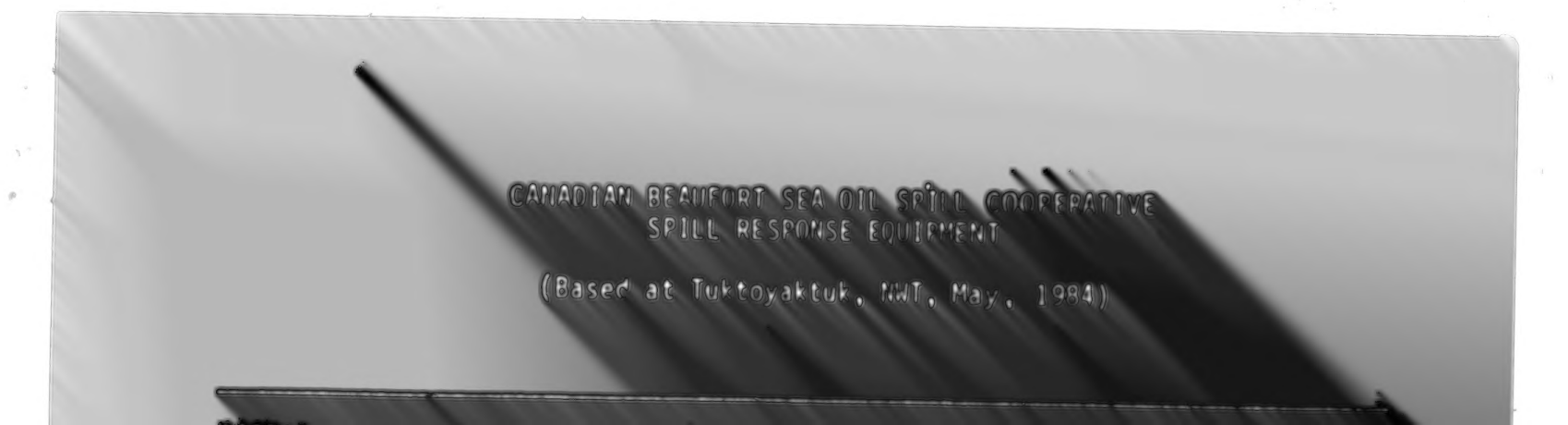
SUPTDOCS/GPO
P. 0162-0186

CG OWNED EQUIPMENT

USCG Marine Safety Office Anchorage
701 C St., Box 17
Anchorage, AK 99513

Contact (907) 271-5137 (Day)
(907) 271-3520 Duty Officer (Night)
(907) 271-3506 Junior Duty Officer (Night)

*Note: Kodiak is a detachment of the Anchorage Office, equipment requests will be handled by Anchorage personnel.

When a discharge emanates from a known source the responsible party shall be strongly encouraged to control or remove such discharge with their own resources. Once it is determined that the polluter is making proper control/removal efforts Coast Guard owned equipment may be available if it's use will "significantly enhance" the removal/control effort when a polluter is willing to remove the discharge but unable to use alternate equipment Coast guard owned equipment shall be made available. Upon the arrival of cooperative or commercial equipment, consideration should be given to the withdrawal of Coast Guard owned equipment unless its use will "significantly enhance" the removal of the discharge. In all cases user fee's for the equipment will be charged to the responsible party. The Coast Guard maintains and periodically updates standard rates to be used in computing reimbursable charges.

Equipment	Location	Quantity
Lockheed Skimmer Model R2003	Anchorage, Alaska	1
Lockheed Skimmer Model 110	Kodiak, Alaska	1
Goodrich Cold Weather Boom	Anchorage, Alaska	6,000 Foot
Goodrich Cold Weather Boom	Kodiak, Alaska	3,000 Foot
Kepner Sea Curtain	Anchorage, Alaska	400 Foot
Kepner Sea Curtain	Kodiak, Alaska	1,000 Foot

Sorbents

Marine Safety Office Anchorage and the two detachments in Kenai and Kodiak maintain fluctuating supplies of assorted sorbents i.e. pads, sweeps, rolls, and booms, totaling approximately $5,000.00 in inventory at any given time.

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Pumps/Generators/Compressors	Location	Quantity
Marlow 4" Diaphragm Pump	Anchorage, Alaska	1
Marlow 4" Diaphragm Pump	Kodiak, Alaska	1
Beard Poulan Generator	Anchorage, Alaska	1
Air Compressor (Trailer Mounted)	Anchorage, Alaska	1
Miscellaneous		
Franklin Heavy Duty Arc Welder	Anchorage, Alaska	1
Hazardous Materials Recovery Drums DOT 17H 85 Gallon Overpac	Anchorage, Alaska	4
Clean-up Tools (Hoes, Rakes, Shorels)	Anchorage, Alaska	Asst. Supply

SEVENTEENTH COAST GUARD DISTRICT
COAST GUARD MARINE SAFETY OFFICE/DETACHMENTS

Unit/Location	Personnel Attached
MSO Anchorage	36
MSO Valdez	49
MSO Juneau	6
MSD Kodiak	2
MSD Ketchikan	8
MSD Sitka	1
MSD Kenai	4

COAST GUARD VESSELS

Name	Location	Crew Complement
CGC STORIS (230)	Kodiak, Alaska	80
CGC YACONA (213)	Kodiak, Alaska	80
CGC FIREBUSH (180)	Kodiak, Alaska	60
CGC IRONWOOD (180)	Kodiak, Alaska	60
CGC CAPE JELLISON (95)	Seward, Alaska	60
CGC SEDGE (180)	Homer, Alaska	60
CGC SWEETBRIER (180)	Cordova, Alaska	60
CGC PLANTREE (180)	Juneau, Alaska	60
CGC CAPE CARTER (95)	Juneau, Alaska	14
CGC ELDERBERRY (65)	Petersburg, Alaska	5
CGC CAPE ROMAIN (95)	Ketchikan, Alaska	14
CGC WOODRUSH (180)	Sitka, Alaska	60

COAST GUARD AIRCRAFT

Location	Number	Comments
Kodiak, Alaska	3	HH3 range 300 mile radius without refueling.
Sitka, Alaska	4	
Kodiak, Alaska	3	HH52 range 150 mile radius without refueling.
Kodiak, Alaska	4	C-130 range throughout Alaska

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ALYESKA PIPELINE - VALDEZ TERMINAL AND PUMP STATION EQUIPMENT

SOURCE: Alyeska Pipeline, 1985.

ALYESKA PIPELINE EQUIPMENT LIST
VALDEZ TERMINAL

MARINE EQUIPMENT	
Tugs	3
Workboats	5
Mooring launches	2
Contingency barge	1

SKIMMERS	
MARCO Class VII (belt)	1
MARCO Class V (belt)	1
Vikoma Seaskimmer (disc)	1
MARCO Class 1	1
Komara	3
SLURP	4
Slickskim Manta Ray	3

VACUUM DEVICES	
Vacuum truck	1
Vacuum system (Skid Mtd)	1
Vac-U-Max	4

CONTAINMENT BOOM	
Seaboom 24" x 12" (back fence)	5000 feet
Curtain type (min 10" x 16")	16,000 feet
Vikoma Seapack	5

SORBENTS	
Boom or Sweeps	5000 feet
Blankets	150
Sorbent Sheets	100 bales

PROTECTIVE CLOTHING	
Life Jackets	50
Boots, rubber	50 pair
Raingear, rubber	50
Gloves, rubber, insulated	100 pair
Hip boots	50 pair

HAND TOOLS	
Bung Wrench	4
Cable Cutter	2
Picks	10
Pitchforks	10
Rakes	10
Sledge Hammer, 5 lb.	3
Shovels, round nose	10
Shovels, sharp shooter	10
Axe, 3 1/2 lb	6

Alyeska Pipeline Equipment List
Valdez Terminal (cont.)

FUEL STORAGE EQUIPMENT

Drums, 55 gal.	50
Fuel cans, 5 gal	24
Pillow tank, 500 gal	4
Pillow tank, 1000 gal	4

MISCELLANEOUS ITEMS

Bolt cutters	1
Anchors, Danforth, HD 25	10
Bags, burlap	2000
Bags, plastic	1000
Buckets, 5 gal	10
Wire rope, 1/2" dia.	2000 feet
Chain, 1/2" galvanized	1000 feet
Fence posts, steel, 6'	50
Membrane liner, 10 mil, rolls	20
Stakes, steel, 1" dia. x 3'	150
Tarpaulin, heavy duty, 20' x 30'	6
Wire mesh, 2" x 2" x 4' (50'/roll)	20 rolls
Wire rope clamps, 1/2"	200
Wire rope shackles, 1/2"	50
Nylon rope	500 feet

WORK EQUIPMENT

Air compressor	2
Bird repellent devices	4
Blinker barricades	10
Hose, discharge, 3"	200 feet
Hose, suction, 3"	100 feet
Lanterns, electric	10
Batteries, lantern	10
Pump, diaphragm 3", gasoline	1
Hose, suction 4"	200 feet
Pump, trash, 4", gasoline	2
Hose, discharge, 4"	200 feet
Pump, hand, 2"	2
Steam cleaner	2
Weed burner, propane	2
Tanker lightering system (STOPS)	2
Pump, diesel, 6"	1
Hose, suction, 6"	50 feet
Hose, discharge 6"	300 feet
Chain saws	2
Portable light plants	4
MARCO power blocks	2

ALYESKA PIPELINE EQUIPMENT LIST
Palletized Equipment

SMALL SKIMMER PALLET

Pump, 2" diaphragm, gasoline powered	1
Pump, 2" diaphragm, hand	1
Hose, suction, 2", 50' sections	2
Skimmer, Acme	1
Skimmer heads, slickskim with 50' hose	1
Valves, 2" scd, L.P.	2
Membrane liner, reinforced, 10 mil. roll 6' x 100'	600 sq. ft. (1 roll)
Buckets, 5 gallon, galvanized	3
Cans, gasoline, 5 gallon, flex nozzle	2
Rope, nylon 1/2"	250'
Pipe fittings:	
Unions, 2" thd	4
Collars, 2" thd	4
Nipples, 2" x 6" thd	4
Reducer, 2" x 1 1/2" thd	4
Camlock adapter to 2" thd	4

BOOM PALLET

Boom, oil containment, w/bridles	300'
Rope, nylon 1/2"	200'
Stakes, steel 1" dia. x 3'	10
Membrane liner, reinforced, 10 mil	600 sq. ft.
Hammer, sledge, 5 lb.	1
Hip boots	2 pair

SMALL TOOLS PALLET

Shovels, round nose	6
Shovels, sharpshooter	6
Pickmattocks	2
Sledge hammer, 5 lbs.	1
Hand saw	1
Rakes	2
Tool Box:	
100' tape	1
Hammer, claw	1
Socket set, 1/2" x 5/8"	1
Screwdrivers, set, phillips, flathead	1
Wrenches, open end, set 1/4" x 1 1/8"	1
Wrenches, crescent, 3" x 10"	1 ea.
Pliers, set	1
Wrenches, pipe, 8"	1
Side cutters	1
Pitchforks	2
Axe	1
Weed burner, propane	1
Buckets, 5 gallon	3
Nails, 10 p	5 lb.
Staples	box
Lanterns, electric	6

SMALL TOOLS PALLETS (continued)

Batteries, lantern	6
Rope, nylon, 1/2"	200'
Pipe fittings:	
Nipple 2" x 6" thd	2
Collar, 2" thd	2
Pump, diaphragm 2", gasoline	1
Hose, 2" suction	200'

SORBENT PALLET

Sorbents:	
Blanket	2
Sheet	4 boxes
Boom	2 boxes
Fence posts, steel, 6'	10
Wire mesh, 2" x 2", 4' wide, 50'/roll	1 roll
Membrane liner, reinforced, 10 mil, roll 6' x 100'	600 sq. ft.
Trash bags, plastic	50
Rope, nylon, 1/2"	200'
Stakes, steel, 1" dia. x 3'	10
Pipe fittings:	
Nipple, 2" thd	2
Collar, 2" thd	2

ICE PALLET

Ice auger	2
Chain saw	1
Membrane liner reinforced, 10 mil roll 6' x 100'	1200 sq ft (2 rolls)
Buckets, 5 gallon	3
Ice chippers	3
Hooks, ice	2
Gloves, insulated, neoprene	10 pr.

HELICOPTER SLINGING PALLET

Cargo, net w/hooks rings	2
Sling, 10'	2
Sling, 20'	2
Swivel hook	2
Safety glasses	2
Rubber insulated gloves	2

CONTINGENCY EQUIPMENT BY LOCATION

Alyeska Pipeline Service Company

	P.S. 1	P.S. 2	P.S. 3	P.S. 4	P.S. 5	P.S. 6	P.S. 7	Fort WW	P.S. 8	P.S. 9	P.S. 10	P.S. 12
OIL SPILL CONTINGENCY PALLETS (Figure 903-3 Lists Pallet contents)												
Small Skimmer Pallets	1		1	2	2				1		2	2
Boom Pallets	2	2	2	4	4	3	1		3	4	4	4
Small Tools Pallets	1	1	1	1	2	1	1		1		2	2
Sorbent Pallets	1	1		1	1				1		1	1
Ice Pallets	2		1	2	2				1		2	2
Helicopter Slinging Pallet	1	1	1	1	1	1						
SORBENTS												
Blankets (rolls)	20	10	10	20	20	10	10	2	10	10	20	10
Booms (cartons)	10	5	5	10	10	5	5	2	5	5	10	10
Pads (cartons)	20	10	10	20	20	10	10	2	10	10	20	10
BOOMS (Not Palletized)												
Containment Boom (ft.)	800	500	200	600	400	1500		600	400	200	400	500
SKIMMERS												
Acme		2				2			1	1		
Komara				1					1			
Manta Ray w/50' hose & floats	1		2	1	1		1					
CLOTHING, PROTECTION												
Boots, Rubber	15	10	10	15	15	15			15	10	15	15
Gloves, Rubber	15	10	10	15	15	15			15	10	15	15
Hip Boots	15	10	10	15	15	15			15	10	15	15
Raingear, Rubber	15	10	10	15	15	15			15	10	15	15
BOATS & MARINE EQUIPMENT												
Anchors, Boat	4	2	2	2	2	2		2	3	2	4	3
Boats, Work, w/trailer	2	1	1	1	1	1			2	1	1	2
Life Jackets	12	6	6	6	6	6		6	9	6	12	8
Line, Nylon, 1/2" (ft.)	1000	1000	1000	1000	1000	1000		500	1000	500	1000	1000
Motors, Outboard	2	1	1	1	1	1		1	4	1	1	2
Boats, w/o trailer								1				
HAND TOOLS												
Bung Wrenches	2	1	1	2	2	2	1		2	1	2	2
Cable Cutters	1			1	1				1	1	1	1
Chain Saws	1				1	1			1	1	1	1
Picks	10	2	2	5	10	5	2		5	2	10	5
Pitchforks	2	2	2	2	2	2	2		2	2	2	5
Rakes	5	2	2	5	5	5	2		5	2	5	5
Sledge Hammers	3	2	2	2	3	2	2		2	2	2	2
Shovels, Sharp Shooter	15	2	2	10	15	5	2		5	2	15	15
Shovels, Long Handle	15	2	2	10	15	5	2		5	2	15	15

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CONTINGENCY EQUIPMENT LOCATION (Cont'd)

Alyeska Pipeline Service Company

	P.S. 1	P.S. 2	P.S. 3	P.S. 4	P.S. 5	P.S. 6	P.S. 7	Fort WW	P.S. 8	P.S. 9	P.S. 10	P.S. 12
FUEL STORAGE EQUIPMENT												
Drums, 55 gal.	20	2	2	10	20	10	2		10	2	20	20
Fuel Cans, 5 gal.	12	2	4	6	12	5	4		5	2	12	12
Bladders, 3000 gal.	1	1	1	1			1		1		1	1
Bladders, 10,000 gal.	1			1		1			2	2	1	1
Bladders, 20,000 gal.	1			1	1	1					1	1
Bladders, 50,000 gal.	2			1					3		2	1
MISCELLANEOUS												
Bags, Burlap	500	200	200	500	500	200	200		200	200	300	300
Bags, Plastic	500	200	200	500	500	200	200		200	200	300	300
Buckets, 5 gal.	20	4	4	10	20	10	4		10	4	20	20
Fence Posts, 6' steel	50	50	50	10	50	50	50		50	50	50	50
Helicopter Cargo Nets									2	2	2	2
Membrane Liner, 10 mi, reinforced, rolls	10	2	2	10	10	5	2		5	2	10	10
Power Ice Augers	1		1	1	1	1			1		1	1
PVC Pipe 8" x 10'	2	2	2	2	2	2	2		2	2	2	2
Stakes, Steel, 1" dia. x 3'	50			10	10				50		50	50
Straw Bales	25								25			25
Tarpaulin, 20'x 30'	3			3	3	1			2		3	3
Wire Mesh, 2" x 2" x 4', 50' rolls	6			10	10	5			5		10	10
EQUIPMENT												
Bird Repellent Devices	2				2				2		2	2
Blinker Barricades	10				10				10		10	10
Hose, Suction, 2" (ft.)	400		200	400	400	200			150	100	150	150
Hose, Discharge/Suction 2" (ft.)									250	100	250	250
Pumps, Diaphragm, 2"	2			2	1	1			2	1	1	1
Hose, Suction, 3" or 4" (ft.)	400			400	400	200	100		100		150	150
Hose, Discharge/Suction 3" or 4" (ft.)							100		100		250	250
Pumps, Diaphragm, 3" or 4"	2			2	2	1	2		2	1	2	2
Lanterns, Electric	10	4	4	10	10	10	4		10	4	10	10
Batteries, Lantern	10	4	4	10	10	10	4		10	4	10	10
Line Thrower	1	1	1	1	1	1						
Portable Winch	1	1	1	1	1	1						
Pumps, Hand, 2"	1	1	1	1	1	1	1		1	1	1	1
Steam Cleaner	1				1				1		1	1
Weed Burners	1				1	1			1		1	1
LUMBER												
2" x 4" x 8'	20			10	20				20		20	20
2" x 6" x 8'	20			10	20				20		20	20
2" x 8" x 8'	20			10	20				20		20	20
4' x 8' x 3/4" Plywood	20			10	20				20		20	20
Stakes, 1" x 2" x 2'	50			25	50				50		50	50

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CANADIAN BEAUFORT SEA

OIL-SPILL-RESPONSE EQUIPMENT

SOURCE: Shell Western E&P, Inc., Sale 87, Oil-Spill-Contingency Plan, March 1985.

CANADIAN BEAUFORT SEA OIL SPILL COOPERATIVE
SPILL RESPONSE EQUIPMENT

(Based at Tuktoyaktuk, NWT, May, 1984)

CATEGORY	QUANTITY	DESCRIPTION
VESSELS	1	Carrier II Sea Truck (Twin 70 Merc)
	1	Carrier III jet boat (Twin 350)
	1	70 hp outboard
	1	Zodiac c/w 20 hp
	1	39' Deployment Vessel Carrier 5
	1	Hiab Model 20 crane on Carrier 5
	1	49' deployment vessel, Neakoolik
Anti-Pollution Barge II	1	216 x 49.5 x 9.6' barge complete with following equipment:
	1	Free water knock out system
	1	VEP skimmer
	1	Watson heater treater/upgrading
	1	Generator load bank
	1	150 kw Cat generator
	--	Modification (house/bulwarks)
	1	600 CFM compressor
	1	5,000 bbl/day burner c/w boom
	1	Power winch
	2	Manual winches
	2	1,000 gal fuel tanks
	1	Oil and water pumping system
	1	Hiab Model 360 crane
	1	250 lb fire extinguisher
	2	Sets breathing apparatus
	--	Firefighting gear
DETECTION	10	Orion tracker buoys
	1	Receiver, Orion
	4	Argos buoys

CATEGORY	QUANTITY	DESCRIPTION
CONTAINMENT	250'	Fireproof boom c/w ISO container
	2,400'	Arctic Boom Mod/77
	4,000'	36" Bennett Navy Boom
	2,500'	18" Bennett inshore boom
	1,000'	36" Bennett Navy Boom Ex Tarsiut
	8	Boom connectors, Navy
	50	Boom connectors
	10	Buoys, fisherman net (15" dia.)
	4	Boom boxes
	6	36" Para Vanes
	10	22 lb anchors
OIL RECOVERY	2	SLURP weir skimmers
	1	Lockheed R2003 skimmer
	1	6" Oil Mop skimmer
	5	Morris MI30 skimmers
	1	Rope mop skimmer
STORAGE	10	Porta Tanks
	3	10,000 gal Uniroyal bladders
	16	1,100 gal Canflex bladders
	1	Open-top Canflex bladder
TRANSFER	1	Homelite pump
	1	Oil separator
	2	3" Spate pumps
	1	3" DP3-1 Homelite pump
	2	3" Spate pumps
	2	3" trash pumps MITM
	1	2" Gorman Rupp centrifugal
	400'	3" arctic hose c/w floats
	250'	2" hose, 25' sections
	--	Couplings
	500'	3" suction hose, Blue Drop
LOGISTICAL SUPPORT Communications	3	Marconi DT 39 radios
	6	Ray 55 radios
	8	DP-15 radios c/w mic, antenna, case
	4	Chargers for above radios

CATEGORY	QUANTITY	DESCRIPTION
LOGISTICAL SUPPORT	4	200 lb anchors
Various	3,200'	2" poly rope
	--	Misc. gear, foul weather
	1	3.5 kw Homelite generator
	2	20 kw diesel generators
OIL DISPOSAL	2	100 bbl/day Saacke burners, complete
	1	Dispersant spray system

CANMAR SPILL RESPONSE EQUIPMENT
(April, 1984)

CATEGORY	QUANTITY	DESCRIPTION	LOCATION
VESSELS	1	39' pollution deployment vessel Twin Cat Diesel Carrier 4	McKinley
	1	17' Davidson lifeboat	McKinley
	1	25 hp OMC outboard	McKinley
	1	14' aluminum boat - Lund	Skauvann
	1	17' Davidson lifeboat	Tuk
	1	20 hp outboard	Tuk
	1	12' Zodiac	Tuk
	1	25 hp Mercury outboard	Skauvann
	1	15 hp OCM outboard motor	Tuk
	1	16' aluminum boat	Tuk
	1	14' aluminum boat	Tuk
	1	12' Zodiac Ex Dome Minerals	Tuk
	1	15' Zodiac Ex Dome Minerals	Tuk
	1	15 hp Evinrude outboard Ex Dome Material	Tuk
	1	20 hp Mercury outboard Ex Dome Material	Tuk
	1	35 hp Evinrude outboard Ex Dome Material	Tuk
CONTAINMENT	800'	36" Bennett Navy Boom	McKinley
	1,000'	36" Bennett inshore boom	Tuk
	2,800'	36" Bennett Navy Boom	Drillships
	1,000'	36" Bennett Navy Boom	SSDC
	6	Aluminum tow bars	
	16	22 lb anchors	Tuk
	26	Buoys, fisherman net, 15" dia.	Tuk
	--	3/4" Poly Line 600	McKinley
	--	3/4" Poly Line 1200	Tuk
	--	1/2" Poly Line 1200	Tuk
	--	3/8" Poly Line 2400	Tuk
	1	200 lb anchor	Tuk
	1,000'	36" Flexi inshore boom	Skauvann
	10	36" pos. buoyancy connectors	Tuk

CATEGORY	QUANTITY	DESCRIPTION	LOCATION
OIL RECOVERY	1	MI30 skimmer	McKinley
	1	Skim Pack 3,000	Tuk
	1	Slick Skim skimmer	Tuk
	1	MI2 skimmer	Tuk
	21 rolls	Sorbent	McKinley
	11 bales	Sorbent boom	McKinley
	4 bales	Particulate	McKinley
	210 bales	Sorbent pads	McKinley
	86 rolls	Sorbent	Tuk
	575 bales	Sorbent pads	Tuk
	150	Sorbent sweeps 1 NT	Tuk
	150	Sorbent boom 2 NT	Tuk
	240	Particulate 2 NT	Tuk
	10 bales	Sorbent pillows	Tuk
STORAGE	4	Bladders, Uniroyal 20,000 gal (old)	Tuk
	1	Bladder, Uniroyal 20,000 gal	Tuk
	1	Bladder, small yellow, 1,000 gal	SSDC
	1	Bladder, small yellow, 1,000 gal	Tuk
	5	Porta Tanks	McKinley
TRANSFER	200'	3" hose, 50' sections	SSDC
	200'	2" hose 2,000	Drillships
	600'	3" hose 9,600	Drillships
	450'	3" hose, 50' sections	McKinley
	600'	3" hose 9,600	Tuk
	65'	3" suction hose, various lengths (3)	Tuk
	350'	2" suction hose, various lengths (11)	Tuk
	110'	1" suction hose, various lengths	Tuk
	800'	1-1/2" fire hose, 100' lengths	Tuk
	25'	2-1/2" hose	Tuk
	200'	3" suction hose, Tarsiut	Tuk
	--	Stock of misc. fittings and adapters	Tuk
	1	2" Komline Sanderson Ex Tarsiut	Tuk
	1	2" Komline Sanderson	Tuk
	1	2" Homelite diaphragm pump	Tuk
	1	3" Spate pump	Tuk

CATEGORY	QUANTITY	DESCRIPTION	LOCATION
TRANSFER (Cont'd)	1	1" Monarch pump	Tuk
	1	2" Monarch pump	Tuk
	5	3" MITM trash pumps	Tuk
	3	1-1/2" Wayjax fire pumps	Tuk
	1	3" Homelite diaphragm pump	Tuk
	1	3" Homelite diaphragm pump	Tuk
	1	2" Komline Sanderson pump	Drillships
	3	3" Spate pumps	Drillships
	1	3" MITM trash pump	McKinley
	1	2" Gorman Rupp centrifugal	Carrier 4
	1	1" domestic water pump, 110 volt	Tuk
	2	3/4" Jobsco electric transfer pumps	Tuk
	1	1" Jabsco electric transfer pump	Tuk
LOGISTICAL SUPPORT Communications	3	DP15 radios c/w mic antenna case	Tuk
	4	5 M 78 channel VHF-FM radio c/w charger, mic	Tuk
	2	Chargers for above	Tuk
	1	Sony colour video camera complete	Tuk
	1	Sony colour Triniton TV	Tuk
	1	Sony Betamax video cassette recorder	Tuk
	1	Sony portable cassette recorder	Tuk
	3	BM/520 Micro Dictators	Cal
	1	35 mm Olympus OM10 camera c/w 50 mm lens	Cal
	1	28 mm lens, wide angle	Cal
	1	Flash unit	Cal
	1	80-210 mm zoom lens	Cal
	1	Tripad Star D.	Tuk
	1	Polaroid camera	Tuk
	2	Binoculars, 7x50 Bushnell	Tuk
LOGISTICAL SUPPORT Various	1	7.5 Homelite generator	Tuk
	2	3.5 kw Homelite generators	Tuk
	1	10 kw Kohler generator	Tuk
	1	3.5 kw Homelite generator	McKinley
	1	3.0 kw Onan-Diesel generator	Tuk
	4	Sets floodlights	Tuk
	1	250 bbl/day Saacke burner	Tuk
	1	Slops disposal oil/water treatment system	Tuk
	1	Yamaha snowmobile	Tuk

CATEGORY	QUANTITY	DESCRIPTION	LOCATION
LOGISTICAL SUPPORT Various (Cont'd)	1	John Deere snowmobile	Tuk
	2	Stihl chain saws	Tuk
	4	Portable heaters c/w ducting	Tuk
	1	Homelite chain saw	Tuk
	1	Bird scare cannon	Tuk
	--	Various fire extinguishers	Tuk
	4	First aid kits	Tuk
	30	Garden rakes	Tuk
	30	Pitchforks	Tuk
	20	Round-mouth shovels	Tuk
	12	Pike poles	Tuk
	12	Paddles, oars	Tuk
	10	Mustang anti-exposure suits	Tuk
	1	Jenny steam cleaner	Tuk
	1	Onan welder	Tuk
	3	HD grinders (hand)	Tuk
	1	Industrial bench grinder	Tuk
	1	3/8" electric drill	Tuk
	1	1/2" electric drill	Tuk
	1	3/4" electric drill	Tuk
	1	Box D power saw	Tuk
	1	B & D Ty saw	Tuk
	1	Wagner electric spray gun	Tuk
	1	B & D screw gun	Tuk
	1	6 amp battery charger	Tuk
	1	60 amp battery charger	Tuk
	1	Webster twin compressor	Tuk
	1	Air spray paint gun	Tuk
	--	Various hand tools	Tuk
	1	Tri axle trailer	Tuk
	1	40 x 60 sprung structure	Tuk
	1	30 x 30 sprung structure	Tuk
	1	HD vacuum cleaner	Tuk
	1	20' 150 container	Tuk
	1	40' 150 container	Tuk
OIL DISPOSAL	3	Warren Springs Dispersant Spray Gear	Tuk
	40	Drums Corexit 9527	Tuk
	20	Drums Oil Sperse 43	Tuk
	20	Drums Value 100	Tuk
	50	Air-deployable igniters	Tuk

ESSO TUK BASE SPILL RESPONSE EQUIPMENT
(September, 1983)

CATEGORY	QUANTITY	DESCRIPTION
VESSELS	1	Sloop with approximately 1,000' Bennett 18" boom
	1	Aluminum barge unit (9' x 25') with 2 Bear Cat 55 hp outboards (on skid)
	2	26' aluminum jet boats
	1	Rubber life raft
	2	6-person lift rafts
	2	8' x 18' Petie barge-type units powered by 2 Bear Cat 55 hp outboards
CONTAINMENT	1,000'	Bennett 18" boom (on sloop)
	200'	Conwed boom
	500'	Bennett 12" boom
	300'	24" Bennett permanent belting boom
	500'	Bennett 36" boom
	500'	Bennett 18" boom
	500'	Bennett 18" Zoom Boom (Esso)
	--	Assortment of anchors, floats, tow bridles, chains, etc.
OIL RECOVERY	1	3" Marlow diaphragm pump (gas motor) with 3" hose and 48" Slick Bar skimmer
	1	Electric wringer and catch tub
	1	Electric Oil Mop unit and boom
	1	8' Pedco skimmer
	1	4' Pedco skimmer
	2	SLURP skimmers (approx. 3')
	2	Water Master 220 volt skimmers
	1	Hand-crank wringer
	1	Bennett skimmer unit complete with motor and pumps
	1	MI-30 skimmer and control unit (gas powered)
	1	8' weir-type skimmer
	1	3' SLURP weir-type skimmer
	9	Containers 4' x 4' x 4' Petrolite (peat moss pillows) with eyelets

CATEGORY	QUANTITY	DESCRIPTION
OIL RECOVERY (Cont'd)	10 boxes	Conwed sorbent pads
	250	4 cu. ft. bags peat moss
	1	I.S.O. container full peat moss (bags)
	6 rolls	Conwed absorbent materials
	3 bales	Conwed 2' x 2' absorbent material
	20 rolls	Grab Oil absorbent material
	1	Hand wringer
STORAGE	4	1,000 gal Porta Tanks
	1	1,000 gal portable tank frame and liner
TRANSFER	4	50' sections neoprene hose (4")
	2	Hand pumps (diaphragm type)
	4	3" Spate diesel-powered pumps
LOGISTICAL SUPPORT	1	40' x 60' canvas shop
	1	20' x 30' canvas shop
	1	12' x 30' steel shop on skids
	3	4' x 4' x 3' boxes anchors
	2 drums	Galvanized anchor chain
	1	12 hp air monitor
	1	3" water monitor
	1	Prossor-Wilco 20 hp pump (for monitor systems)
	17 bales	Sacks (for sandbagging)
	5	45 gal drums (marker buoys)
	10	30 gal drums (marker buoys)
	15	Plastic marker buoys
	approx. 1,000'	1" rope
	approx. 1,000'	3/4" rope
	approx. 800'	5/8" rope
	approx. 1,000'	1/2" rope
	1 set	Shop handtools
	2	110-220 volt, 4 KVA ONAN generators
	1	110-220 volt, 4.5 KVA ONAN generator
	6	50 lb anchors
	6	Marker buoys
	--	Assortment made-up ropes
	2 boxes	Hand tools (pitchforks, shovels, saws, hammers, bars, etc.)

CATEGORY	QUANTITY	DESCRIPTION
LOGISTICAL SUPPORT (Cont'd)	5	Disposable emergency tents
	10 to 15	Disposable emergency sleeping bags
	24	Life vests
	24 pr.	Rubber boots
	24 pr.	Rubber gloves
	24	Rubber suits
	--	Assortment cooking utensils

GULF SPILL RESPONSE EQUIPMENT
(April, 1984)

CATEGORY	QUANTITY	DESCRIPTION	LOCATION
VESSELS	1	16' aluminum boat c/w 40 hp outboard	Nalluk Base
	1	16' aluminum boat c/w 40 hp outboard	Herschel Basin
DETECTION	10	Orion tracking buoys c/w receiver and helicopter antennae	Herschel Basin
CONTAINMENT	1,600'	36" Sanivan "Saniboom" c/w accessories in 2 quick-deployment containers	Gulf Beaufort
	1,200'	24" Versatech inshore boom c/w accessories in 2 quick-deployment containers	Nalluk Base
	1,000'	30" heli-portable Versatech Zoom Boom c/w accessories in 2 quick-deployment containers	Nalluk Base
	600'	30" Versatech Nav-Pak boom c/w accessories in quick-deployment container	Herschel Basin
	2,000'	24" Sanivan boom c/w accessories	Herschel Basin
	2,000'	24" Sanivan boom c/w accessories	Nalluk Base
OIL RECOVERY	1	MI-30 disk skimmer	Herschel Basin
	1	MI-30 disk skimmer	Nalluk Base
	2	Skim-Pak 4200 portable skimmers	Nalluk Base
	1	Skim-Pak 4200 portable skimmer	Herschel Basin
	--	Variety of sorbents	Gulf Beaufort
	--	Variety of sorbents	Nalluk Base
	--	Variety of sorbents	CDU Kulluk
	--	Variety of sorbents	Herschel Basin
STORAGE	2	1,000 gal collapsible tanks	Gulf Beaufort
	[illegible]	1,000 gal collapsible tanks	Herschel Basin
	2	1,000 gal collapsible storage tanks	Nalluk Base

CATEGORY	QUANTITY	DESCRIPTION	LOCATION
STORAGE (Cont'd)	1	50 cu. m. Dunlop heavy-duty arctic bladder	Nalluk Base
	3	10 cu. m. Versatech CL-10 bladders	Nalluk Base
TRANSFER	1	3" MI-T-M trash pump	Gulf Beaufort
	1	3" MI-T-M trash pump	Nalluk Base
	2	3" MI-T-M trash pumps	Herschel Basin
	1	2" Homelite diaphragm pump	CDU Kulluk
	1	2" Homelite diaphragm pump	Nalluk Base
	2	2" Homelite diaphragm pumps	Herschel Basin
	50 m	3" arctic hose c/w fittings and adapters	Gulf Beaufort
	160 m	3" arctic hose c/w fittings and adapters	Herschel Basin
	60 m	3" arctic hose c/w fittings and adapters	Nalluk Base
	110 m	2" arctic hose c/w fittings and adapters	CDU Kulluk
	60 m	2" arctic hose c/w fittings and adapters	Nalluk Base
	350 m	2" arctic hose c/w fittings and adapters	Herschel Basin
LOGISTICAL SUPPORT	--	Miscellaneous handtools and support equipment	Nalluk Base
	--	Variety of handtools and support equipment	Herschel Basin
OIL DISPOSA	100	Energetex air-deployable igniters	Nalluk Base

Abbreviation/Acronym Glossary

ABSORB	Alaskan Beaufort Sea Oilspill Response Body
ACMP	Alaska Coastal Management Program
ACS	Alaska Clean Seas
ADEC	Alaska Department of Environmental Conservation
AGTV	active gated television
AMOP	Arctic Marine Oil Spill Program
API	American Petroleum Institute
BAST	Best Available and Safest Technology
BIOS	Baffin Island Oil Spill
CANMAR	Canadian Marine Drilling, Ltd.
CCRS	Canada Centre for Remote Sensing
CFR	Code of Federal Regulations
CIRO	Cook Inlet Response Organization
COE	Corps of Engineers
CRREL	Cold Regions Research and Engineering Laboratory
CZM	coastal zone management
DOI	Department of the Interior
DOT	Department of Transportation
DPP	development and production plan
EA	environmental assessment
EIS	environmental impact statement
EP	exploration plan
EPA	Environmental Protection Agency
EPS	Environmental Protection Service (Canada)
FR	Federal Register
FRU	Halliburton Services Fast Response Unit
GOACO	Gulf of Alaska Cleanup Organization
IR	infrared
ITL's	Information to Lessees
LLLTV	low-light-level television
MMS	Minerals Management Service
MODU	Mobile Offshore Drilling Unit

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Abbreviation/Acronym Glossary - Continued

MOU	Memorandum of Understanding
MWSU	Mobile Well Servicing Unit
NASA	National Aeronautics and Space Administration
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NOS	Notice of Sale
OCS	Outer Continental Shelf
OCSEAP	Outer Continental Shelf Environmental Assessment Program
OHMSETT	Oil and Hazardous Material Simulated Environmental Test Tank
OSC	On-Scene Coordinator
OSCP	Oil-Spill-Contingency Plan
RRT	Regional Response Team
RS	Regional Supervisor
RSFO	Regional Supervisor, Field Operations
RU	Research Unit
SAR	Synthetic Aperture Radar
SLAR	Side-Looking Airborne Radar
SLURP	Self-Leveling Unit for the Recovery of Pollutants
SMSS	Swedish Maritime Surveillance System
SOCK	Spilt Oil Containment Kit
SSC	Swedish Space Corporation
USC	United States Code
USCG	U.S. Coast Guard
USDOD	U.S. Department of Defense
USGS	U.S. Geological Survey
UV	ultraviolet (radiation)

END

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